



MONASH University

**Religion and Healthy Eating among
Seventh-Day Adventists in West Malaysia**

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Global Public Health,
Jeffrey Cheah School of Medicine and Health Sciences

Dedicated to Ting Ting, my daughter

This is your thesis too!

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ABSTRACT

Introduction: Religion/Spirituality has been shown to be salutary on health, and a possible link between religion and positive health outcomes is diet. Research has shown that religiosity is associated with better diet but most studies were conducted in a multi-denominational context, which might be confounded with theological differences. Thus, the first aim of this study was to examine the relationship between individual religiosity and diet within a homogenous group of believers.

Neighbourhood characteristics have an effect on health above and beyond the effect of the individual characteristics of those living in the neighbourhood. Neighbourhood might affect the health of its residents by influencing the adoption and maintenance of health behaviours. People of the same faith often practice religious activities together and religious congregation could be considered a community of faith and similar to neighbourhoods. Thus, the characteristics of a religious congregation might influence the health behaviour and health of the congregants. The second aim of this study was to examine whether congregational conservativeness would be significantly associated with the diet of congregants even after taking account of their demographics and individual levels of religiosity.

This study also examined whether social gradient exists in a group of health-conscious Christian and whether health behaviours (dietary habits, alcohol consumption and exercise) mediate the relationship between religiosity and health outcomes (systolic and diastolic blood pressure and blood glucose level).

Methods: The study population was all Seventh-Day Adventists residing in West Malaysia, aged 18-80. This study used a cross-sectional, multilevel survey design. There were two surveys; the first was congregational and the second, individual. In the first survey, 45 congregations returned questionnaires about congregational conservativeness. In the second survey, 574 Adventists returned questionnaires about religiosity, diet, lifestyle, self-reported history of diseases and demographics. One hundred of the 574 Adventists also participated in a healthy screening where their blood pressure, blood glucose level, weight and height, and waist and hip circumferences were measured.

To examine the relationship between individual religiosity and diet and whether social gradient existed in the diet of the participants, multiple regressions were conducted. Multilevel linear regressions were conducted to determine whether congregational conservativeness was significantly associated with the diet of the congregants above and beyond individual factors. To examine whether health behaviours mediated the relationship between religiosity and health outcomes, path analysis was conducted.

Results: While none of the religious variables were significantly associated with fruit and vegetable intake, a higher level of religiosity was associated with better dietary habits and vegetarian status. Congregational conservativeness predicted individual dietary habit above and beyond individual characteristics; a higher congregational conservativeness was positively associated with better individual dietary habits scores. None of the religious variables were associated with fruit and vegetable intake at individual and congregational level. Social gradient still existed in the dietary habits of the participants. Health behaviours did not mediate the relationship between religiosity and health outcomes; the direct effect of religiosity on health outcomes was more important than the indirect effect.

Conclusions: The finding supports the role of religion as a potential channel to promote health by encouraging the believers to adopt a healthy diet.

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PUBLICATIONS DURING ENROLMENT

Sections of my thesis have been published, accepted or submitted for publication in refereed journals:

1. Tan, M.M, Chan, C.K.Y & Reidpath, D.D. (2013). Religiosity and Spirituality and the Intake of Fruit, Vegetables and Fat: A Systematic Review. *Evidence-Based Complementary and Alternative Medicine*.
2. Tan, M.M, Chan, C.K.Y & Reidpath, D.D. (2013). Faith, food, and fettle: Is individual and neighbourhood religiosity/spirituality associated with a better diet? *Religions* 5, 801-13.
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THESIS INCLUDING PUBLISHED WORKS

GENERAL DECLARATION

In accordance with Monash University Doctorate Regulation 17.2 Doctor of Philosophy and Research Master's regulations the following declarations are made:

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes three original papers published in peer reviewed journals and no unpublished publications. The core theme of the thesis is religion, spirituality and health. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the Jeffrey Cheah School of Medicine and Health Sciences under the supervision of Prof. Daniel D. Reidpath and Dr. Carina K. Y. Chan.

In the case of chapters 2, 5 and 6, my contribution to the work involved the following:

Thesis chapter	Publication title	Publication status*	Nature and extent (%) of students contribution
2	Religiosity and spirituality and the intake of fruit, vegetable and fat: A systematic review	Published	70%
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6	Does the social gradient remain in the dietary habits of a health conscious population? A study of Seventh-Day Adventists in West Malaysia	In press	70%

* e.g. 'published'/'in press'/'accepted'/'returned for revision'

I **have**/have not renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

Signed:

Date:

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THESIS OUTLINE

Chapter 1 outlines the history of religion, spirituality and health and how religion and spirituality might influence health. Issues in the study of religion, spirituality and health are discussed. The research aims, objectives and questions and the significance of research are included.

Chapter 2 reviews past studies on religion, spirituality and diet. The social determinants of health and the role of neighbourhood in influencing the health of its residents are discussed. It also includes the major health studies conducted among the Seventh-Day Adventists.

Chapter 3 describes the sampling frame, recruitment of participants and methods used to answer the research questions.

Chapter 4 presents the descriptive results of the participants, which include demographics, religiosity, diet, lifestyle, self-reported anthropometric measures and history of diseases.

Chapter 5 includes a published paper that reports the results of the study on the relationship between individual religiosity and dietary behaviours. Additional statistical analysis is included and the results are compared with those of the published paper.

Chapter 6 includes a published paper that reports the results of the social gradient study on dietary habits.

Chapter 7 describes the findings from the multilevel modelling of congregational characteristics and individual dietary habits and vegetarian status.

Chapter 8 reports the results of path analysis of religion, spirituality and health outcomes mediated by health behaviours.

Chapter 9 summarizes the main findings of the study and describes the strengths and limitations of this study, and the implications for health promotion.

CHAPTER 1: INTRODUCTION

Religion/spirituality has been shown to have a salutary effect on physical and mental health. Many religions believe in the sanctity of human body and one of the proposed mechanisms where religion/spirituality benefits health is through the practice of health-promoting behaviours. In addition, the characteristics of the religious neighbourhood where a believer belongs to might also encourage him or her to adopt health-promoting behaviours and thus leading to positive health outcomes at individual level.

The focus of this thesis was to examine the relationship between religion/spirituality and health and dietary behaviours. Diet is an important part of religion and many religions have laws regarding what food to eat or to avoid. This thesis includes four sub-studies: (1) an examination of the relationship between individual religiosity and dietary habits; (2) an examination of social gradient in the dietary habits of a group of health-conscious Christians; (3) a multilevel examination of whether congregational characteristics predict individual dietary habits above and beyond individual religiosity; and (4) a mediation analysis of health behaviours in the relationship between religion, spirituality and health outcomes.

This introduction chapter contains six sections. The first section provides an overview of the history of religion, spirituality and medicine. The associations between religion, spirituality and mental and physical health are also included.

The second section discusses four proposed mechanisms where religion benefits health. The third section discusses two main issues in the study of religion, spirituality and health: conceptualization and measurements of religion/spirituality. The research aim, objectives and questions are presented in the fourth and fifth sections. The last section discusses the significance of the study.

1.1. Religion, Spirituality and Medicine: A Brief History

Religion and medicine have a long interwoven history. They coexisted ever since the appearance of human societies. Their separation only occurred about two to three hundred years ago (Koenig, 2000).

During prehistoric times and ancient civilizations such as in Egypt and Mesopotamia, there was no distinction between a religious leader and a healer. Diseases were understood in the context of religion – either they were due to possession and disturbance by demons or evil spirits, or a sign of displeasure of gods towards their followers. Religious leaders i.e. priests, were believed to possess supernatural power and able to communicate with gods, through which they would be able to heal the sick. To placate the offended gods or to exorcise, the priests performed the specific rituals and rites such as prayers, casting of spells, dancing, incantations, and presentation of offering. The preparation of medicines, which consisted of herbs and animal parts, was commonly accompanied with incantations, and prescribed together with amulets. The sick might also need to

perform religious rites during treatment and when taking medicines (Magner, 2005).

Even Greco-Roman medicine, the foundation of modern Western medicine and known for its emphasis on empirical evidences and rationality, also has an “irrational” side that explained diseases in terms of religion (Eijk, 2011). Asclepius¹, the god of medicine and healing, was widely worshipped in Greece. Hippocrates, the Father of Medicine, who believed that diseases had natural rather than supernatural causes, “traced his ancestry back to Asclepius on his father’s side and to Hercules on the maternal side” (Magner, 2005). Renowned second century A.D Greek physician Galen, a prolific writer whose contributions in physiology influenced Western medicine for a several centuries, believed that human anatomy and functions were designed by God (Subbarayappa, 2001).

During the Christian era, caring for the sick played a significant role in religion. The central figure of Christianity, Jesus, was both an itinerant Old Testament teacher and a healer. Christianity, “a religion of salvation or healing” according to Adolf Harnack (1908), manifests such interest in caring for the sick because of Jesus’s injunction to clothe the poor and look after the sick (Matthew 25:36, New International Version). Furthermore, the rise of demonology during the third century, where there was a growing emphasis on the role of demons in disease causation, helped paved the way for the caring for the sick to emerge as the principal part of Christianity in the fourth century (Ferngren, 1992).

¹ whose snake-entwined staff is a modern symbol of medicine

Religion and medicine remained interwoven throughout the Middle Ages (400-1400 A.D). The theologians of the time divided medicine into two categories: human medicine, which employed physical treatment such as bloodletting, prescription of herbs and drugs; and religious medicine, which included prayers and exorcism (Magner, 2005). Diseases were still regarded as punishments from God or a test of faith – the medieval people believed that successful healing was by itself a miracle, even when human medicine was used. The Church then was the major care provider for the sick. Few laypersons were practicing medicine; most of the physicians were monks or priests. The duty to care for the sick paved way to the establishment of institutionalized care. St. Basil, bishop of Caesarea founded the first major hospital in Asia Minor, just outside the wall of Caesarea, around 370 A.D for the poor and the sick (Conrad et al., 1995).

However, during the twelfth century A.D, the Church was concerned about monks making monetary gains from medical practice and neglecting their clerical duties, and thus issued decree forbidding them from attending medical lectures (Carson et al., 2012). They were allowed to practice medicine but not for monetary gains. The restrictions placed on monks led to medicine becoming a more secular practice carried out by laypersons.

Further separation between religion and medicine occurred at the beginning of Renaissance, around 1400 A.D, when the certification of physicians became the responsibility of the state (Koenig, 2000). The church continued to provide care for the sick but its influence was reduced due to the prevailing abuses and

superstitions. With the coming of the Enlightenment period the role of the church in medicine was further reduced. The end of French Revolution on 1802 also marked the complete separation of religion and medicine (Koenig, 2000).

For the next 200 years, the antagonism from the scientific community toward religion gradually surfaced. The publication of Charles Darwin's book, *On the Origin of Species*, in which he proposed the theory of evolution, further undermined the status of religion. Thomas Huxley, a supporter of Darwin, wrote extensively against religion and became its main opponent.

In 1872, Sir Francis Galton, a cousin of Charles Darwin, conducted a retrospective case-control study on the efficacy of prayer by going through the official death records. He compared the lifespan of members of royal house, who were being prayed publicly and frequently; clergy (who prayed for others regularly); and lay persons; and found that all three groups passed away around similar age (Galton, 1872). Then he compared the still birth rates between praying and non-praying women and found them similar too (Galton, 1872). Thus, Galton concluded that prayer does not improve health. This study was probably the very first scientific attempts to verify the relationship between religion and health.

As religion and medicine went their separate ways, the former attracted a new group of researchers – the psychologists, hence a new discipline, the “psychology of religion,” arose during the late nineteenth century. Some of the pioneers in this field included the founding fathers of psychology such as William James, G.

Stanley Hall, J. H. Leube and D. Starbuck. They were interested in religious phenomena and their effects on behaviours and health. The nineteenth century also saw the flourish of academic journals related to the psychology of religion (Beit-Hallahmi, 1974).

However, the psychology of religion went out of favour during the 1930s, most likely due to the rise of psychoanalysis and behaviourism (Beit-Hallahmi, 1974). Sigmund Freud, the founder of psychoanalysis and a fervent critique of religion, labelled religion as pathological – “Religion is comparable to a childhood neurosis” (Freud, 1989). Any research related to religion was looked upon with suspicions by the scientific community. Beit-Hallahmi (1974) commented about the change of trends in psychology since the 1930s: “sex became a very fashionable area of research, while religion became a taboo subject.” Those who wanted to venture into the psychology of religion were intellectually ostracised. To make the matter worse, the scientific studies of religion and spirituality were flawed methodologically. It was also commonly assumed that religiosity and spirituality could not be studied scientifically because they are immaterial and out of the realm of science (Miller & Thoresen, 2003).

However, during the 1990s, the interest in religion and medicine was reignited, partly due to improved research methodology and the increased evidence that religion is salutary to health (Miller & Thoresen, 2003). Starting in the early 1990s, the study of religion and health has been increasingly recognized as a legitimate domain of scientific inquiry and is becoming more established (Miller & Thoresen,

2003). The number of studies related to religion and spirituality is on the rise yearly. Weaver et al. (2006) examined the number of articles published between 1965 and 2000 and concluded that there is a “statistically significant upward trend across years... for the rate of articles dealing with religion and spirituality.” In the United States, religion is being incorporated into medical school syllabus. In 2000, 70 out of 126 medical schools in the U.S are offering religion and medicine as elective or compulsory courses, whereas 10 years ago only 5 were doing so (Koenig, 2000).

Between 2000 and 2010, at least 21,000 quantitative studies examining the relationship between religion and health have been published (Koenig et al., 2012), covering a wide range of health outcomes and behaviours and many of them have shown that religion has a positive association with health (Chatters, 2000). The positive association has been found consistently in diverse samples, designs, methodologies, religious measures, health outcomes, and population characteristics (Levin & Chatters, 1998b), for example, adolescents (Lytle et al., 2003; Wong et al., 2006), middle-aged and the elderly (Levin et al., 1996); men and women (Hixson & Morgan, 1998; Pitel et al., 2012); Jews (Benjamins, 2012; Shmueli & Tamir, 2007), Protestants and Muslims (Abdel-Khalek, 2007, 2010); in cross-sectional (Ayers et al., 2010), case-control (Burazeri, 2008), and cohort studies (Lee et al., 2009); in developed countries (Hill et al., 2007) as well as the less developed ones (Naewbood et al., 2012); and in different ethnic groups (Arredondo et al., 2005; Fife et al., 2011; Levin & Markides, 1988).

1.1.1. Religion, Spirituality and Mental Health

Historically, in Western medicine, religious organizations provided the best healthcare for the mentally ill in the early Christian era; unfortunately, during the Renaissance, religious organizations were also the fiercest oppressor and persecutors of the mentally ill (Koenig & Larson, 2001). As mentioned earlier, religion and spirituality were seen as incompatible in psychology and it was only during the 1990s that it was being examined more seriously. About 80% of the studies looking at the relationship between religion and health examined mental health, and the majority of them showed a positive association between religion and lower risks of a wide range of mental illness and disorders (Koenig, 2012).

Depression, one of the most common mental disorders, is the fourth leading cause of burden among all diseases (World Health Organization, 2001). The majority of studies that examined religion and depressive symptoms showed that a higher level of certain dimensions of religiosity such as intrinsic religiosity, religious attendance, and religious involvement is associated with reduced risks of depressive symptoms and disorders (Koenig & Larson, 2001; McCullough & Larson, 1999). Clinical trials that examined the effects of religious interventions on depression also found that depressed religious patients who received religious interventions such as discussions about the Koran and pastoral counselling recovered faster compared with those that received non-religious intervention or no intervention (Azhar & Varma, 1995; Propst et al., 1992; Razali et al., 1998). In addition to depression, other studies also showed a protective effect of religion

against suicide, which is one of the most severe outcomes of depression (Dervic et al., 2004; Gearing & Lizardi, 2009; Nisbet, 2000).

In addition to depression and suicide, a higher level of religion has been found to be associated with various psychological outcomes such lower stress level (Chang et al., 2001; Larson, 2006; Oman, 2006), better psychological well-being (Ellison, 1991; Green & Elliott, 2010; Levin & Chatters, 1998a), lower level of negative emotions such as anxiety among mainline Protestant and frequent church attenders (Koenig & George, 1993).

1.1.2. Religion, Spirituality and Physical Health

The effects of religion on nearly every type of major diseases including cancers has been studied (Levin & Chatters, 1998b). The positive link between religion and positive physical health might stem from the positive influence of religion on mental health, the fact that religion helps to reduce stress level and buffers the negative effects of stress physiologically (Koenig et al., 2012).

The majority of the earlier studies on religion and physical health compared religions or religious denominations and have focused on cardiovascular diseases, hypertension and stroke, and overall and cause-specific mortality (Levin & Chatters, 1998b). Religious denominations that have stricter behavioural rules, such as the Seventh-Day Adventists, Mormons and Orthodox Jews, tend to have relatively lower risks of cardiovascular diseases, hypertension, stroke, cancer at various sites, and lower overall and cause-specific mortality compared to the general population (Levin & Schiller, 1987).

More recent studies that examined the level of religiosity also reported a salutary effect of religion on cardiovascular diseases and hypertension (Burazeri, 2008; Jaffe, 2005; Obisesan et al., 2006; Powell et al., 2003). A higher level of religiosity is also associated with fewer risk factors of cancer (Gillum & Williams, 2009) and better quality of life and life satisfaction among cancer patients (Ringdal, 1996; Yates et al., 1981). A 12-year longitudinal study assessed the risk of functional disability among 2812 elderly people and found that frequent religious attendance predicted a delayed onset of disability and better functioning (Idler & Kasl, 1997).

1.2. Proposed Links between Religion, Spirituality and Positive Health Outcomes

Chatters (2000) outlined several categories of factors that link religion and positive health outcomes. They include (1) lifestyle and behaviours; (2) social resources; (3) coping resources and behaviours; (4) positive attitudes, beliefs and emotions, based on previous studies (Ellison, 1991; Ellison & Levin, 1998; Idler, 1987; Levin, 1996; Levin & Chatters, 1998c; Levin & Vanderpool, 1989; Maton & Wells, 1995),

1.2.1. Lifestyle and Behaviours

One of the proposed mechanisms by which religion benefits health is through the adoption of religious practices that are also health-promoting (Ellison & Levin, 1998). Many religions view the human body as sacred and include specific prohibitions against unhealthy behaviours, which are considered irreverent and not only harmful physically but also spiritually. This view, however, needs to be tempered by the fact that some religious adherence *may* also result in poorer health outcomes, such as extreme asceticism. Notwithstanding that, numerous

studies have shown that religion is negatively associated with many harmful behaviours such as smoking (Blay, 2008; Koenig, George, Cohen, et al., 1998), alcohol drinking (Michalak et al., 2007; Patock-Peckham et al., 1998), substance abuse (Miller et al., 2000; Steinman, 2008), risky sexual activities (Rostosky et al., 2003; Whisman et al., 2007); and positively associated with good health behaviours such as the use of preventive health care services (Benamins, 2006; Benamins & Brown, 2004), physical activity (Strawbridge et al., 2001), and seat belt use (Suris et al., 2005).

1.2.2. Social resources

Another mechanism whereby religion might benefit health is through a variety of social resources such as social ties and social support available to the members within a religious community. Religious gatherings offer ample opportunities for social interactions. Considerable evidence shows that various aspects of social resources are positively associated with better physical and mental health (Thoits, 2011; Uchino, 2006, 2009). Compared to less frequent attenders and non-attenders, those who attend religious services regularly had larger and denser social network, received more instrumental support from other members within the religious community, and reported feelings of being cared for and valued (Ellison & George, 1994). The role of religious support in the relationship between religion and health has only begun to be examined recently and studies have shown that social support received from other members within the religious community where one belongs mediates the relationship between religion and physical health (Krause, 2006a; Olphen et al., 2003) and mental health (Kendler et al., 2003; Nooney & Woodrum, 2002).

1.2.3. Coping resources and behaviours

Coping is the process of interpreting and responding to stressors (Lazarus & Folkman, 1984, p. 141). Empirical evidence has shown that stress-coping strategies have an effect on health (Halonen & Davis, 2001). Religious coping is the efforts to understand and deal with life's stressors in ways related to the sacred (Pargament et al., 2011) and is distinctive from nonreligious coping (Fetzer Institute, 1999; Pargament et al., 1990). Religious coping also helps people find meaning in life's challenging events and situations. Many people use religious coping to deal with a wide range of illness and negative life events, and they tend to cope more effectively than those who do not use religious coping (Pargament et al., 1990; Pieper et al., 1992). Religious coping also add unique variance to the prediction of health above and beyond non-religious coping (Pargament, 2001).

Pargament et al. (2011) proposed two opposite patterns of religious coping: positive religious coping, where people use religion to seek spiritual support and negative religious coping, where people express doubts about God. Positive religious coping is associated with better health outcomes; negative religious coping, on the other hand, is associated with worst health outcomes and behaviours (Pargament et al., 2004; Witvliet et al., 2004) .

1.2.4. Positive attitudes, beliefs and emotions

Religion might boost positive emotions and help neutralize negative emotions and encourage related positive psychological traits (Koenig, 2012). Religion is positively associated with wellbeing, self-esteem and optimism (Crabtree & Pelham, 2009; Koenig & Vaillant, 2009; Krause, 2003; Krause, 2006b). Through the

teaching of humility, which might increase a sense of guilt due to the high moral standards and focus on sin, religion seems to be detrimental to one's self-esteem. On the other hand, religious doctrines, which view the deity as loving and caring, might encourage positive attitudes and beliefs about one's self worth, thus helping a person to find meaning in life and improves his or her self-esteem. Low self-esteem is associated with the development of depressive symptoms subsequent to life stress (Roberts & Kassel, 1997) and higher free cortisol stress responses (Pruessner et al., 1999), and religion might be beneficial to health through promoting self-esteem.

Interestingly, even though it is expected that a religious person, who believes that God or the Transcendent is in control of the world, would exhibit greater external locus of control, studies have shown that religious people tend to have a greater internal locus of control (Pargament & Hahn, 1986). A study showed that locus of control mediated the relationship between religiosity and life satisfaction (Norman, 1995). In addition, religions also encourage positive emotions such as forgiveness, optimism, which are also associated with better health (Lawler et al., 2005; Szondy, 2006; Toussaint et al., 2001).

1.3. Issues in Religion, Spirituality and Health Research

- 1.4. [This section relies substantially on, and incorporates a published systematic review on the relationship between religion, spirituality, and the intake of fruit, vegetable and fat intake (Tan et al., 2013)]

1.3.1. Conceptualization

In the research of religion and health, one of the major issues is defining religion and spirituality in a way that supports their measurement. Historically, the notions of religion and spirituality have often been used interchangeably; however, recently there has been a trend towards distinguishing the two concepts (Hill et al., 2000). Broadly, religion include “beliefs, practices, and rituals related to the Transcendent or the Divine” (Koenig, 2011) while spirituality is concerned with the “connection to that which is sacred, the transcendent” and also “a search for the transcendent and the discovery of the transcendent” (Koenig et al., 2012). Religion/religiosity tends to convey a negative impression that it is related to organized religion and theological rigidity while spirituality is viewed more positively and is associated with personal experience of the transcendent.

For research purposes, Koenig (2011; 2012) recommends the understanding of spirituality within the context of religion, and making a distinction between people who are “(1) spiritual (the deeply religious) (2) those who are not deeply religious but for whom religion may be a part of their lives (the religious, but not spiritual), and (3) those who are neither religious nor spiritual and who might be called secular or humanistic.” In other words, spirituality is considered a subset of religion. The category “spiritual but not religious” is excluded to avoid confusion.

In this study, the definitions according to Koenig (2011; 2012) were used. Unless otherwise specified, the term religion/religiousness/religiosity were used interchangeably with spirituality.

1.3.2. Measurements

The measurement of religiosity remains a significant challenge for research in the area. Religiosity is a latent construct which is not directly observable but may be inferred from a series of indicators, such as religious attendance and private religious activities (Miller & Thoresen, 2003). Disentangling the relationship between religion and health is further complicated because of overlaps in the latent constructs. Many spirituality scales include items that measure positive psychological states such as peacefulness, meaningfulness etc., which when correlated with health outcomes, guarantees a positive relationship, because these positive psychological states are already positively associated with positive health outcomes (Koenig, 2008a). For example, the 20-item Spiritual Well-Being scale, which contains 10 existential well-being items that also measure psychological well-being (Paloutzian & Ellison, 1982). Some other common latent constructs include attitude, health, cognition etc. “Great care must be used to identify and verify the validity of such indicators” (Berry, 2005). Thus, religion scales that contain positive psychology items should be avoided.

Historically, religion and health research has been mainly conducted among believers of Judeo-Christian faith, and most studies were carried out in the U.S. As a result, the common measures of religion have been developed for these contexts and may not be suitable for Eastern religions, especially those practiced outside the U.S. The concern necessarily raises the issue of whether it is possible to have a universal/global measure of faith (faith-neutral) or whether there is a need for specific measures for religion (faith-specific) (King & Crowther, 2004) since

different religions might have a different understanding of a theological concept (e.g. devotion to God) and different practices for the same concept. For example, while weekly church attendance is encouraged in Christianity, in Hinduism and Buddhism temple worship could be done on any day and at any time during the week.

The most commonly used religion measure has been the single-item religious attendance measure because of its “ease of use” (Hall et al., 2008). In addition, in many studies, religion data were collected as part of large epidemiological or social studies whose focus was not religion and health and this can be a drawback (Hill & Pargament, 2003; Levin, 1994). It is generally accepted that religion is a multidimensional construct (Fetzer Institute, 1999), which means that a single-item measure such as religious attendance will be insufficient to capture all dimensions except possibly in the most general sense. This also limits insights that can be gained about the relationship between religion and health. Recently, more specific scales have been developed to measure different dimensions of religion (Fetzer Institute, 1999).

In order to capture the multidimensional aspect of religion, in this study other dimensions of religion such as private religious activities, intrinsic religiosity and Sabbath-keeping were also measured, in addition to religious attendance. These scales were developed in a Christian context and they were (as will be seen shortly) suitable for the participants of this study, who were also Christians.

1.4. Research Aim and Objectives

The aim of this study was to understand the relationship between religion/spirituality and health. The specific objectives were:

- To understand the relationship between individual religiosity and healthy diet
- To identify whether social gradient still exists in the dietary habits of a health-conscious population
- To identify whether the composition of religious congregations had an effect on individual diet above and beyond the individual effects of religiosity
- To understand the relationship between religiosity, health behaviours, and measurable health outcomes

1.5. Research Questions

The research questions of the study include the following:

- I. What is the relationship between individual religiosity and diet among Seventh-day Adventists in West Malaysia?
- II. Does congregational conservativeness predict individual diet over and above individual factors (religiosity and demographics)?

Additional subsidiary research questions included the following:

- I. Does the social gradient remain in the dietary habits of the Seventh-Day Adventists in West Malaysia?

II. Do alcohol consumption, dietary habits and exercise mediate the relationship between individual religiosity and health outcomes among the Seventh-day Adventist in West Malaysia?

**Individual religious variables include organized religiosity (attendance of religious services), non-organized religiosity (private religious activities such as prayer, reading of religious literature), intrinsic religiosity and Sabbath keeping.*

1.6. Significance of Research

Religion is considered important by many people around the world (Crabtree & Pelham, 2009). One recent survey estimated that 51% of the population in the world believe in god(s) (Duffy, 2011). Another survey conducted in 143 countries showed that the majority of people, especially those from Africa and Asia, held that religion is an important part of their lives (Crabtree & Pelham, 2009). In Malaysia, 99.07% of the population have a religion (Department of Statistics, 2011).

Specifically, this thesis examined the relationship between religion and dietary behaviour. Unhealthy diet is a major risk factor in the development of non-communicable diseases (NCD), which are responsible for about 63% of death globally (2011). The World Health Organization (WHO) made the following recommendations for an optimal diet (World Health Organization, 2013a):

- Achieve energy balance and a healthy weight

- Limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats and towards the elimination of trans-fatty acids
- Increase consumption of fruits and vegetable, and legumes, whole grains and nuts
- Limit the intake of free sugars
- Limit salt (sodium) consumption from all sources and ensure that salt is iodized

Globally, diet-related diseases kill about 36 million people every year (World Health Organization, 2003). Malaysia is one of the developing countries undergoing a nutrition transition, where there is a “shift away from relatively monotonous diets of varying nutritional quality... toward more varied diets that include more pre-processed food, more foods of animal origin, more added sugar and fat, and often more alcohol” (Popkin et al., 2001, p. 3). The prevalence of diet-related diseases in Malaysia is expected to increase (Noor, 2002). Thus, there is an urgency to promote healthy eating in the country.

Food plays an important role in religion and many religions have laws about food. It is possible that people who consider religion important will also follow the diet required by their religion. The long-term dietary practices required by most religions could have an influence on the adherents' health and the outcomes of diet-related diseases. Many solutions have been proposed to reduce the incidence of diet-related disease, thus, the current study could help to explore whether religion could be another channel to promote healthy eating.

Most of the previous studies on religion and health included samples from the U.S and other Western countries; there are only a handful of studies from Asia and Africa. The current study was conducted in Malaysia, an Asian country where the research of religion, health, and diet is still underexplored. It is unknown whether Malaysians experience similar health benefits from religion as those from the Western countries, and the current study aimed to examine whether religion influenced diet differently in a multiracial setting in Malaysia.

In this study, the Seventh-day Adventist in West Malaysia was chosen as the target population. The Adventists are a group of conservative Christians and according to the Adventist doctrine, the believers are to shun biblically unclean meat such as pork and shellfish, and smoking and alcohol are strictly prohibited. Vegetarianism is encouraged because it is believed that that is the original diet intended by God. If Adventists chose not to be vegetarians, they are still encouraged to consume more fruit, vegetable and nuts, and less animal products. In North America, about 36% of the Adventist vegans/vegetarians and Adventists enjoy better health than the general population (Butler et al., 2008). However, it is unknown whether the Adventists in West Malaysia also exhibit similar prevalence of vegetarianism and experience similar health benefits as those Adventists in North America.

Smoking and alcohol consumption are rare among the Adventists (Butler et al., 2008). Even though there is no smoking and alcohol consumption statistics of

Malaysian Adventists, it is very likely that the prevalence of these two practices are also low among Adventists in Malaysia since smoking and alcohol drinking are prohibited according to Adventist doctrine of health. As smoking and alcohol consumption are the two major confounding factors in nutritional research, the very low prevalence of the two practices means that the Adventists are an ideal group for epidemiological study.

The earlier studies of Adventists compared Adventists with other religions or Christian denomination. However, the study of religion and diet should also go beyond simple denominational comparisons. Potentially insightful studies include those that examine degree of religiosity/spirituality and diet within a single denomination. Every denomination has different teaching about diet, thus a single denominational study eliminate the need to control for denominational differences (Lee et al., 2009). Another aim of this study was to examine the relationship between religion and diet in a single denomination.

Social gradient has been shown to exist in many health outcomes and health behaviours where people with higher socioeconomic status (SES) enjoy better health and are more likely to be involved in health-promoting behaviours (Adler & Ostrove, 1999). Adventists are a group of health-conscious Christians. Typically, before joining the Adventist church through baptism, a person will go through Bible study that includes lessons on healthy living, and baptized Adventists who attend religious services regularly are exposed to various church-based health promotion activities. It is likely that SES plays a lesser role in influencing the

health behaviours of the Adventists. This study also examined whether social gradient still existed in the dietary habits of the Adventists.

Even though religion is practiced individually, it is also a community activity, and each religious congregation is a miniature neighbourhood by itself, where adherents of the same faith gather regularly and interact with each other. It has been recognized that the characteristics of the neighbourhood where individuals live has an impact on their health behaviours above and beyond individual characteristics (Macintyre et al., 1993). It is possible that the characteristics of religious congregations also influence the dietary choices of the congregants. Even though healthy diet is part of Adventist doctrine, there might be different level of adherence in different congregations. It is possible that the more conservative congregation tends to adhere more strictly to the dietary guidelines. However, it is unknown whether the characteristics of a congregation exert an influence on dietary practices of its members above and beyond individual characteristics. Congregational effect and dietary intake has never been explored. Thus, another aim of the current study was to investigate whether congregational characteristic predict dietary intake over and above individual effects by using multilevel analysis.

CHAPTER 2: LITERATURE REVIEW

This chapter comprises of four sections. The first section is a literature review on religions, spirituality and diet. This section includes a published systematic review on the relationship between religion, spirituality and the intake of fruit, vegetable and fat, and a discussion of the relationship between religion, spirituality and other dietary measures. The second section examines the social determinants of health. The third section discusses neighbourhood and health. The fourth section provides an overview of the health studies conducted among the Seventh-Day Adventists.

2.1. Religion, Spirituality and Diet

[This section relies substantially on, and incorporates a published systematic review on the relationship between religion, spirituality, and the intake of fruit, vegetable and fat intake (Tan et al., 2013)]

As mentioned in Introduction, one of the proposed mechanisms that religion benefits physical health is through health-promoting lifestyle and behaviours. Certain health practices are endorsed and encouraged by most religions, such as healthy eating. In fact, most religions have specific dietary guidelines regarding what food to eat or avoid. These guidelines fall into two categories. The first category involves “a temporal abstinence from all or certain foods (fasting)” – the majority of religions have fasting guidelines; for example, Muslims fasting during Ramadan, and oriental orthodox Christians fasting before Holy Communion. The second category relates to “stable and distinctive dietary habits that differ from

the general population”; for example, Muslims consume halal meat, and Jews consume kosher meat (Sabate, 2004).

The main purposes of these dietary guidelines are for spiritual advancement rather than health *per se*. However, the long term dietary practices required by certain religions could be a protective factor in preventing diet-related diseases. For example, the Seventh-day Adventist Church and the Church of Jesus Christ of the Latter-day Saints both encourage their believers to consume more fruit and vegetable and less fat. There is evidence that Adventists, Mormons and adherents of religions with strict dietary guidelines have healthier diets, better physical health and longer lifespans than the general population (Enstrom, 1978; Mills et al., 1994). Even in religions that do not have specific dietary guidelines or restrictions, the teaching that the body is sacred might encourage the adoption of a healthier diet. There is evidence that where a religion has stipulated dietary requirements that (intentionally or unintentionally) endorse a diet that empirically is found to result in better health outcomes, adherents of that faith tend to have better health outcomes.

Notwithstanding the importance of food in many religions, there is a surprising scarcity of research on the relationship between religion and diet. According to the first edition of the Handbook of Religion and Health (Koenig et al., 2001), the most comprehensive review about religion and health to date, there were only seven studies on religion and diet before 1990. The second edition of this Handbook (2012) reviewed 21 studies about religion and diet between year 2000

and 2012. Sixty-two per cent showed a positive association i.e. higher measured religiosity is associated with a healthier diet.

A few other reviews also identified generally positive associations between religion and a healthier diet. Groan and Van Der Heid (1959), for instance, reviewed the role of dietary cholesterol in the development of atherosclerosis and coronary thrombosis among adherents of different religions. They found that Jews and vegetarian Trappist monks have a lower cholesterol level than the comparable groups. Shatenstein and Ghadirian (1998) reviewed the differences in health behaviours, including dietary practices, among different religious groups. In another review, Sarri, Higgins, and Kafatos (2006) examined religious dietary practices and physical health among Muslims, Seventh-day Adventists, orthodox Christians, Jews, Buddhists, and a few other religions. There was an inconsistent finding about the influence of Ramadhan fasting on physical health among Muslims, and an overall positive relationship between religious dietary practices and health in other religions.

2.1.1. Religion, Spirituality and the Intake of Fruit, Vegetable and Fat

2.1.1.1. Introduction

The majority of studies in religion and diet focused on the intake of fruit, vegetable and fat. The following paper is a systematic review on the association between religion and the intake of fruit, vegetable and fat. Thirty-nine studies were included in the systematic review, and they were divided into two categories:

1) Denominational studies that compared fruit, vegetable and/or fat intake between members of different religions, or denominations within the same religion, or between a religion with the general population; and 2) Degree of religiosity studies that examined the degree of religiosity and its association with fruit and vegetable and/or fat intake.

2.1.1.2. Declaration for Thesis Chapter 2.1.1

Declaration by candidate

In the case of Chapter 2, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
<ul style="list-style-type: none">• Conducted systematic review• Wrote the draft	70

The following co-authors contributed to the work:

Name	Nature of contribution	Extent of contribution (%)
Daniel D. Reidpath	Provided advice in systematic review and revised the draft	15
Carina K. Y. Chan	Provided advice in systematic review and revised the draft	15

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work*.

Candidate's Signature	Date

Main Supervisor's Signature	Date

Review Article

Religiosity and Spirituality and the Intake of Fruit, Vegetable, and Fat: A Systematic Review

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Objectives. To systematically review articles investigating the relationship between religion and spirituality (R/S) and fruit, vegetable, and fat intake. **Methods.** PubMed, CINAHL, and PsycInfo were searched for studies published in English prior to March 2013. The studies were divided into two categories: denominational studies and degree of R/S studies. The degree of R/S studies was further analyzed to (1) determine the categories of R/S measures and their relationship with fruit, vegetable, and fat intake, (2) evaluate the quality of the R/S measures and the research design, and (3) determine the categories of reported relationship. **Results.** Thirty-nine studies were identified. There were 14 denominational studies and 21 degree of R/S studies, and 4 studies were a combination of both. Only 20% of the studies reported validity and 52% reported reliability of the R/S measures used. All studies were cross-sectional, and only one attempted mediation analysis. Most studies showed a positive association with fruit and vegetable intake and a mixed association with fat intake. **Conclusion.** The positive association between R/S and fruit and vegetable intake may be one possible link between R/S and positive health outcome. However, the association with fat intake was mixed, and recommendations for future research are made.

1. Introduction

Unhealthy diet is a major risk factor in the development of noncommunicable diseases (NCD), which are responsible for about 63% of deaths globally [1]. One of the main characteristics of a healthy diet is the regular consumption of a variety of fruit and vegetable, which is associated with a lower risk of some cancers, coronary heart disease, hypertension, and stroke [2, 3]. About 1.7 million deaths worldwide are attributed to a low fruit and vegetable intake [4]. In addition, about 14% of gastrointestinal cancers, 11% of ischemic heart disease, and 9% of stroke worldwide are also attributable to low fruit and vegetable intake [5]. Another important dietary factor related to health is fat intake. A high fat intake is associated with higher risk of coronary heart disease, diabetes, and cancers, the common NCDs [6–8].

The World Health Organization recommends a daily intake of at least 400 g (5 servings) of fruit and nonstarchy vegetable, and fat that is less than 30% of total dietary energy, of which less than 10% is from saturated fat and less

than 1% from transfat [9]. However, due to urbanization and westernization, many countries that traditionally enjoyed high fruit and vegetable and low dietary fat consumption are moving towards a higher fat, lower fiber diet [10]. The global burden of NCD is predicted to increase further because of this global transition in lifestyles [10].

Research has shown that religion and spirituality (R/S) has a positive association with health [11]. About 80% of the studies looking at the relationship between R/S and health examined mental health [12], showing a positive association with wellbeing, self-esteem, and optimism [13–16]; lower scores of depressive and suicidal symptoms [17, 18]; and lower stress level [19–21]. Numerous studies have also reported a positive association between R/S and physical health, including an association with lower all-cause mortality and lower rates of diet-related diseases such as hypertension, cardiovascular diseases, and cancer [22–26].

The study of the relationship between R/S and health remains relatively novel. Initially it was not well accepted because it was thought that it is impossible (within a positivist

framework) to study R/S scientifically. However, starting in the early 1990s, with the improvement of methodology, the study of religion and health has been increasingly recognized as a legitimate domain of scientific inquiry and is becoming more established [27]. Between 2000 and 2010, at least 21,000 quantitative studies examining the relationship between R/S and health have been published [28], covering a wide range of health outcomes and behaviors.

In the research of R/S and health, one of the major issues is defining religion and spirituality in a way that supports their measurement. Historically the notions of religion and spirituality have often been used interchangeably; however, recently there has been a trend towards distinguishing the two concepts [29]. Broadly, religion includes “beliefs, practices, and rituals related to the Transcendent or the Divine” [30], while spirituality is concerned with the “connection to that which is sacred, the transcendent” and also “a search for the transcendent and the discovery of the transcendent” [28]. Religion tends to convey a negative impression that it is related to organized religion and theological rigidity, while spirituality is viewed more positively and is associated with personal experience of the transcendent. However, Koenig recommends the use of spirituality in the context of religion, that is, those who are spiritual are “deeply religious” [30].

The most commonly used R/S measure has been the single-item measuring religious attendance because of its “ease of use” [31]. In most of the studies that have used a religious attendance measure, most have also found that it is positively associated with better health outcomes [32]; for example, it has been associated with lower mortality rates [33, 34], better adoption of health behaviors [35, 36], more life’s satisfaction [37], and a lower prevalence of hypertension [24]. However, in many studies, R/S data were collected as part of a larger study, and this can be a drawback [38, 39]. It is generally accepted that R/S is a multidimensional construct [40], which means that a single-item measure such as religious attendance will be insufficient to capture all dimensions except possibly in the most general sense. This also limits insights that can be gained about the relationship between R/S and health. Recently, more specific scales have been developed to measure different dimensions of R/S [40].

Religion is considered important to many people around the world. One recent survey estimated that 51% of the population in the world believe in god(s) [41]. Another survey conducted in 143 countries found that the majority of people, especially those from developing countries, reported that religion was an important part of their lives [14].

One of the proposed mechanisms by which R/S benefits health is through the adoption of religious practices that are also health-promoting [42]. Many religions view the human body as sacred and include specific prohibitions against unhealthy behaviors, which are considered irreverent and not only harmful physically but also spiritually. This view, however, needs to be tempered by the fact that some religious adherence *may* also result in poorer health outcomes, such as extreme asceticism. Notwithstanding that, numerous studies have shown that R/S is negatively associated with many harmful behaviors such as smoking [43, 44], alcohol drinking [45, 46], substance abuse [47, 48], and risky sexual activities

[49, 50] and positively associated with good health behaviors such as the use of preventive health care services [51, 52], physical activity [36], and seat belt use [53].

Certain health practices are endorsed and encouraged by most religions, such as healthy eating. In fact, most religions have specific dietary guidelines regarding what food to eat or avoid. These guidelines fall into two categories. The first category involves “a temporal abstinence from all or certain foods (fasting)” —the majority of religions have fasting guidelines, for example, Muslims fasting during Ramadan and oriental orthodox Christians fasting before Holy Communion. The second category relates to “stable and distinctive dietary habits that differ from the general population”; for example, Muslims consume halal meat and Jews consume kosher meat [54]. The main purposes of these dietary guidelines are for spiritual advancement.

R/S might encourage the consumption of fruit and vegetable and discourage fat intake (especially animal fat) because of specific doctrines of a particular religion. For example, the teaching of Ahimsa (do no harm) in Mahayana Buddhism and Hinduism encourages their adherents to be vegetarians in order to cultivate compassion, since eating animals requires slaughtering. Nonvegetarian food is considered impure and could hinder one’s spiritual development [55]. The Seventh-day Adventists are encouraged to be vegetarians, as part of a religious duty to maintain a healthy body [56]. Even in religions that do not have specific dietary guidelines or restrictions, the teaching that the body is sacred might encourage the adoption of healthier behaviors, including a healthier diet.

The long term dietary practices required by certain religions could be a protective factor in preventing diet-related diseases. For example, the Seventh-day Adventist Church and the Church of Jesus Christ of the Latter-day Saints both encourage their believers to consume more fruit and vegetable and less fat. There is evidence from observational studies that Adventists, Mormons, and adherents of religions with strict dietary guidelines have healthier diets, better physical health, and longer lifespans than the general population [57, 58].

Notwithstanding the importance of food in many religions, there is a surprising scarcity of research on the relationship between R/S and diet. According to the first edition of the Handbook of Religion and Health [59], the most comprehensive review about R/S and health to date, there were only seven studies on R/S and diet before 1990. The second edition of this Handbook (2012) reviewed 21 studies about R/S and diet between 2000 and 2012. Sixty-two percent showed a positive association; that is, a higher measured R/S is associated with a healthier diet.

A few other reviews also identified generally positive associations between R/S and a healthier diet. Groen and van der Heide [60], for instance, reviewed the role of dietary cholesterol in the development of atherosclerosis and coronary thrombosis among adherents of different religions. They found that Jews and vegetarian Trappist monks have a lower cholesterol level than the comparable groups. Shatenstein and Ghadirian [61] reviewed the differences in health behaviors, including dietary practices, among different religious groups.

In another review, Sarri et al. [62] examined religious dietary practices and physical health among Muslims, Seventh-day Adventists, orthodox Christians, Jews, Buddhists, and a few other religions. There was an inconsistent finding about the influence of Ramadan fasting on physical health among Muslims and an overall positive relationship between religious dietary practices and health in other religions.

However, to date, there has been no review that examined the relationship between R/S and specific dietary intake. The past reviews have only examined R/S and diet in general. Thus, the purpose of our review was to address this gap and systematically review the relationship between R/S and fruit, vegetable and fat intake. We hypothesized that R/S was positively associated with fruit and vegetable intake, and negatively associated with fat intake.

2. Methods

2.1. Search Strategy. PubMed, CINAHL, and PsycInfo were searched by using two categories of key terms: religious key terms (religion, religiosity, religiousness, and spirituality) and dietary key terms (diet, food, food habits, health behavior, food preferences, eating, nutritional status, fruit, vegetable, fibers, and fats). The Boolean operator "OR" was used to combine key terms within each category, and "AND" to combine both categories. In PubMed database, the "NOT" operator was also used to eliminate studies related to clinical trials, fasting, reviews, systematic reviews, case reports, editorial, and comment. The full search strategy can be obtained from the authors.

2.2. Inclusion Criteria. To be eligible for inclusion, a paper had to fulfill the following criteria.

- (1) The research analyzed the direct association between at least one quantified R/S measure and at least one quantified measure of fruit and vegetable or fat intake. Thus, qualitative studies and case studies were excluded.
- (2) The paper was published in English and in a peer-reviewed journal before 1 March 2013.

2.3. Exclusion Criteria. A paper was excluded if

- (1) R/S and fruit, vegetable, and/or fat intake were included but their relationship was not examined directly (e.g., parents' R/S and children's intake)
- (2) only overall health/dietary behavior was assessed but not fruit, vegetable, and/or fat intake specifically
- (3) R/S was included as part of the measure of another variable (e.g., social support) but the direct relationship between R/S and fruit, vegetable, and/or fat intake was not assessed;
- (4) the focus of the paper was fasting and/or eating disorders;
- (5) the paper examined *only* serum levels of nutrients and not direct intake. Serum level or biomarkers of

nutrients might not be an accurate indicator of fruit, vegetable, and fat intake since the nutrients could be obtained from supplements;

- (6) the paper examined fiber intake but *did not* specify its dietary source as fruit and vegetable. Fiber could be obtained from supplements and nonfruit or vegetable food source such as grains.

The references and bibliographies of the papers were also examined to identify other relevant articles. Previous reviews of the relationship between diet (generally) and R/S were also examined [28, 59, 61, 62], and in one case the review author was contacted for his list of papers, which were not detailed in the review itself.

3. Analysis

The frequency and types of fruit, vegetable, and fat intake measures used were first examined. The measures were categorized into dietary records, 24-hour dietary recall, food frequency, brief dietary assessment methods, and dietary history. A dietary record is a detailed record of all food and drinks consumed over a period of time by a respondent; in 24-hour dietary recall, a respondent is asked about the food and drinks he/she consumed during the past 24 hours; a food frequency questionnaire is a list of commonly consumed food that could be selected by respondents; brief dietary assessments are used to estimate the intake of a nutrient or a type of food but do not assess overall diet; dietary history assesses dietary patterns over time [63].

The studies were divided into two categories: (1) denominational studies that compared fruit, vegetable, and/or fat intake between members of different religions, or denominations within the same religion, or between a religion with the general population and (2) degree of R/S studies that examined the degree of R/S and its association with fruit and vegetable and/or fat intake. The two categories were analyzed separately.

The analyses of degree of R/S studies were guided by Rew and Wong [64] and Wong et al. [65]. First the categories of R/S measures were analyzed. The classification scheme was based on Wong et al. [65], which is a modification of Hackney and Sanders [66]. There are six categories: institutional (social and behavior aspects of R/S e.g., attendance and social support), ideological (R/S beliefs e.g., importance of religion), personal devotion (personal and internalized devotion, e.g., private prayer), existential (measures that are spiritual but not religious, e.g., spiritual wellbeing), multidimensional (examined more than one category of R/S), and generic (e.g., one-item measure that asks about how religious are the respondents) [65]. The relationships (positive (+), negative (-), mixed, or none) between R/S measures and fruit, vegetable, and fat intake were identified.

The quality of R/S measures was assessed by examining whether their validity and reliability were reported. The number of studies that used single-item measure was also examined. Many R/S and health studies relied solely on the use of single-item measure of religious attendance, which has its limitations in health research [38]. The quality of research

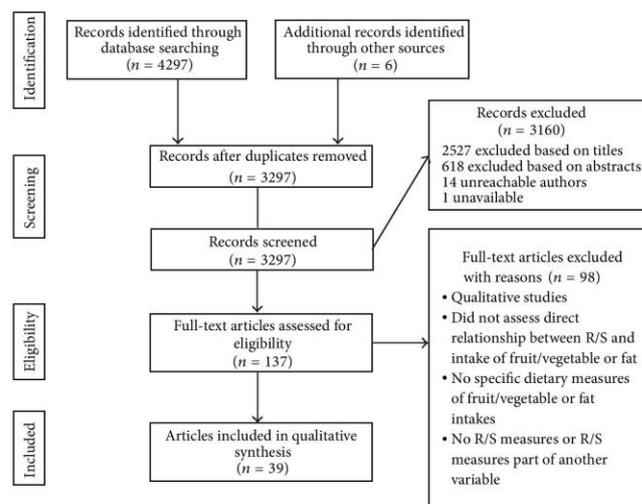


FIGURE 1: Articles selection process.

design (control for covariates, utilization of longitudinal data, and investigation of mediators) was assessed [64]. The studies were also categorized based on their reported relationship between R/S and fruit, vegetable, and fat intake.

4. Results

Out of the 3298 potentially relevant papers identified by the database search strategy, 32 papers fulfilled the inclusion criteria. An additional seven papers were obtained through cross reference of included papers and previous reviews. Figure 1 shows the flowchart of article selection process. All of the 39 studies were cross-sectional. There are 14 denominational studies that do not contain other R/S measures, 21 studies that examined only degree of R/S, and four that included both denominational differences and degree of R/S. See Table 1 for the table of characteristics of the 39 studies.

The majority (77%) of the studies were conducted in the United States. Five were conducted in other Western countries (two in Australia (5.1%), and one each (2.6%) in Scotland, Slovakia, and Canada), two in Israel (5.1%) one in Japan (2.6%), and one in South Korea (2.6%). Four studies included only female samples. Eleven studies were race-specific; seven examined African Americans, two examined non-Hispanic Whites, one examined Koreans, and one examined Japanese. Thirty-two of the studies (79.4%) included samples that were predominantly Christians. Four studies examined Jews and three examined Buddhists.

4.1. Assessment of Dietary Intake. Out of the 39 studies, 12 examined fruit, vegetable, and fat intake, 14 examined only

fruit and vegetable intake, and the other 13 only examined fat intake.

Table 3 shows the categories of dietary assessments of fruit, vegetable, and fat intake. Among the five categories of dietary assessment methods, brief dietary assessments were the most used, followed by food frequency. The most used brief dietary assessment was the Fat- and Fiber-Related Behavior Questionnaire [67], which was included in four studies, followed by the National Institute's 5-A-Day Survey [68], which was included in three studies. Three studies used more than one dietary assessment method, and two used more than one brief dietary assessment.

4.2. Denominational Studies. A total of 18 studies were analyzed. Eight (44%) of them compared Seventh-Day Adventists with the other denominations (Catholics, Methodists, and Mormons) or non-Adventists, three compared fruit, vegetable, and fat intake, three compared only fruit and vegetable intake, and two compared only fat intake. Among the six studies that compared fruit and vegetable intake, three (50%) showed that Adventists consumed significantly more fruit and vegetable than members of other denominations and non-Adventists, one (16.7%) had positive but nonsignificant association, one was nonsignificant in vegetable intake but significant in higher fruit intake, and one showed that Adventists consumed less deep fried vegetable.

Five studies compared total fat intake between Adventists and non-Adventists. Two (40%) showed that Adventists consumed less fat. One showed that Adventists consumed less fat when comparing total fat in grams, but similar amount of fat as non-Adventists when comparing the percentage of energy from fat. Another study showed that Adventist

TABLE 1: Characteristics of studies included in the systematic review of the associations between R/S and fruit and vegetable or fat intake. Only variables related to this systematic review are reported in this table.

(a) Denominational studies (Adventists versus others)										
No.	First author (publication year)	Location	N	Population	Sampling method	Denominations	Dietary measures F/V	Dietary assessment methods	Finding	Control variables
1	Alexander (1999) [72]	Denver, USA	94	Adults	Convenience	Adventists Catholics	✓ ✓	FFQ	Adventists (i) more fruit/vegetable (ii) less fat (iii) less saturated fat (iv) less % energy from saturated fat Nonsignificant: (i) polyunsaturated fat (ii) % energy from polyunsaturated fat (iii) % energy from fat	Gender
2	Hunt (1988) [73]	LA, California, USA	290	Postmenopausal women	Convenience	Adventists Methodists	✓	24 hr dietary recall	Adventists nonsignificantly more fruit and vegetable ($P = 0.08$)	None
3	Kent (2009) [74]	Melbourne, Australia	1054	Adults	Random	Adventists Non-Adventists	✓	FFQ	Adventists more fruit and vegetable	Age
4	Kuczmariski (1994) [75]	North Carolina, USA	227	Adolescents	Convenience	Adventists Non-Adventists	✓ ✓	FFQ	Adventists (i) males & females: more fruit (ii) females: more fats	None
5	Rouse (1983) [76]	Perth, Australia	293	Adults, 22–44 yrs	Convenience	Adventist (vegetarians & omnivores) Mormons (omnivores)	✓	24 hr dietary recall	Mormon males more total fat & saturated fat intake than male Adventist vegetarians Polyunsaturated fat—Adventist vegetarians > Mormons > Adventist omnivores P:S ratio—low in SDA omnivores and Mormons	None
6	Sabaté (1990) [77]	USA	1765	School children, 1st–10th grades	Random	Denominational school—SDA or public	✓	FFQ	Adventist school children more fruit/vegetable	No
7	Shultz (1983) [78]	Oregon, USA	23	Adults	Random	Adventists (vegetarians) Non-Adventists (nonvegetarians)	✓	3-day dietary record FFQ	3-day dietary record: nonsignificant, though non-Adventists 18% more total fat FFQ (i) Non-Adventists more deep fried vegetable (ii) Non-Adventists more animal fat and more saturated fat	None

(a) Continued.										
No.	First author (publication year)	Location	N	Population	Sampling method	Denominations	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
8	Fraser (1987) [79]	LA & Orange Counties, USA	320	Non-Hispanic Whites, 35–55 yrs	Random (Adventists) & convenience (non-Adventist neighbors)	Adventists Non-Adventists	✓	FFQ	Adventists—less fat, less saturated fat, higher P : S ratio; linoleic acid none	None
(b) Denominational studies (other religions/denominations)										
No.	First author (publication year)	Location	N	Population	Sampling method	Denominations	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
9	Epstein (1956) [80]	New York, USA	415	Garment workers, >40 yrs	Random	Italian Jewish Others	✓	24-hr dietary recall	Italians and Jews—no difference in fat intake Jews more animal fats	None
10	Glick (1998) [81]	Yates Country, NY, USA	149	Old order Mennonites	Unclear	Mennonite USA population	✓	FFQ	Mennonites males & females more fat & oleic acid than USA sample Mennonite males—similar % calories from fat with USA sample	None
11	Kita (1988) [82]	Kyoto, Japan	36	Adults, 24–35 yrs	Convenience	Zen monks University students	✓	24-hr dietary recall	Zen monks less fat intake & higher P/S ratio	None
12	Lee (2009) [83]	Gyeongbuk, Republic of Korea	85	Females—Buddhist nuns & Catholic nuns	Convenience	Buddhists Catholics	✓	Fat in % kcal Total fat Plant fat Animal fat	No differences in fat in % kcal, total fat, plant fat Catholics more animal fat	None
13	Mullen (2000) [84]	West of Scotland, UK	985	Adults, >35 yrs	Stratified random	Catholics Non-Catholics	✓	FFQ	Catholics—pure fruit juice Catholic males—less fruit and vegetable	Sex, occupational class
14	Shatenstein (1993) [85]	Greater Montreal, Canada	250	Hassidic families	Random	Hassidic sects—Outremont Hassidim & Lubavitcher Hassidim	✓	Food frequency & food habits list 2-day food record	Lubavitcher Hassidim more cooked fruit	None
(c) Denominational + degree of R/S studies										
No.	First author (publication year)	Location	N	Population	Sampling method	R/S measures	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
15	Kim (2004) [86]	USA	546	Adults	Random	Religious denomination Religious attendance Religious application Religious commitment Religious identity Religious coping Religious social support	✓	National Cancer Institute's Quick Food Scan	Conservative Protestant/others/no religion women more fat than Catholic women Males—none	Age, race, education, marital status, employment

(c) Continued.

No.	First author (publication year)	Location	N	Population	Sampling method	R/S measures	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
16	Kim (2008) [87]	Texas, USA	424	Non-Hispanic Whites, 58–100 yrs	Random	Denomination Attendance Religious social support (% network in church & % network in religion)	√	Interview about fat reduction behavior	All R/S measures nonsignificant for men Women—Denomination nonsignificant; more % network in church, less fat reduction behavior; more % network in religion, more fat reduction behavior	Age, SES, urban-rural residence, living with someone, chronic illness, physically disabled, health & disability, general social support
17	McIntosh (1984) [88]	Virginia, USA	371	Elderly	Random	Religious participation Religious salience Religious disagreement Religious preference	√	24 hr dietary recall	+ve for salience and fat intake +ve for disagreement and fat intake More localistic, Methodists more fat, Brethren less fat	Sex, income
18	Schlundt (2008) [89]	Nashville, Tennessee, USA	3014	White & African Americans, >18 yrs	Stratified random	Religious denomination/affiliation Religious involvement Index (religious attendance, religiosity, perception of religion as a source of strength and comfort)	√ √	Eating Behavior Patterns Questionnaire Eating Styles Questionnaire (both Adapted from Behavioral Risk Factor Surveillance System)	Denomination—nonsignificant Religious involvement index positively associated with healthy eating behaviors and high-fat behaviors	Age, sex, race, education, income & employment
(d) Degree of R/S studies										
No.	First author (publication year)	Location	N	Population	Sampling method	R/S measures	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
19	Arredondo (2005) [90]	USA	211	Women, 18–65 yrs	Random	Church attendance	√ √	Block fat & fiber screener	Frequent churchgoers more fiber than nonchurchgoers Churchgoers (frequent & infrequent) more fiber than nonchurchgoers	Education, marital status, employment, age

(d) Continued.

No.	First author (publication year)	Location	N	Population	Sampling method	R/S measures	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
20	Baruth (2011) [91]	South Carolina, USA	1136	African Americans, >18 yrs	Random	Perceived environmental church support (perceived written informational, perceived spoken informational, perceived instrumental, total perceived church support)	✓ ✓	National Cancer Institute Fruit and Vegetable screener Servings of fruit and vegetable Fat- and Fiber-Related Behavior Questionnaire	More fruit and vegetable (i) more total perceived church support, perceived written informational support & perceived spoken informational support More low-fat behavior (i) more total perceived church support and perceived written informational support	Sex, years of education, health rating, age, BMI, influence of church
21	Benjamins (2012) [92]	USA	351	Jewish students, 5th–8th grades	Convenience	Religious beliefs & health	✓	Youth Risk Behavior Survey (5 fruit and vegetable daily)	Nonsignificant	Gender, weight status, dieting, parental involvement, confidence
22	Debnam (2012a) [93]	USA	2370	African Americans, >21 yrs	Probability-based but not representative	Religion social support (emotional support received, emotional support provided, anticipated support, negative interaction)	✓	National Cancer Institute's Five-A-Day Survey	More social support, more fruit and vegetable (i) additive effect: emotional religious support	Age, education, sex, self-rated health status
23	Debnam (2012b) [94]	USA	2370	African Americans, >21 yrs	Random	Spiritual Health Locus of Control Scale (active spiritual, passive spiritual)	✓	National Cancer Institute's 5-A-Day Survey	Overall: +ve for active spiritual and daily fruit servings -ve for passive spiritual and daily vegetable servings Males: -ve for passive spiritual and daily vegetable servings; nonsignificant for fruit Females: -ve for passive spiritual and daily vegetable servings; none for fruit	Age, education, health status

(d) Continued.

No.	First author (publication year)	Location	N	Population	Sampling method	R/S measures	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
24	Fife (2011) [95]	Northeast, USA	510	African American university students	Convenience	Duke University Religion Index	✓	Youth Risk Behavior Survey (i) Ate no fruit during the past 7 days (ii) Ate no salad during the past 7 days (iii) Drank no 100% fruit juice during the past 7 days	Chi-square test: (i) nonsignificant—ate no fruit during the past 7 days; ate no salad during the past 7 days (ii) significant—drank no 100% fruit juice during the past 7 days Logistic regression: (i) univariate & multivariate—“intrinsic only” group more likely to drink no 100% fruit juice during the past 7 days	Year in school, gender
25	Franklin (2007) [96]	USA	1273	Adults, 18–96 yrs	Stratified random	Religious health fatalism questionnaire	✓	Fat-increasing behavior Fat-decreasing behavior	High fatalism +ve associated with both high fat-increasing behavior & high fat-decreasing behavior	Age, race, gender, income, education
26	Friedlander (1985) [97]	Jerusalem, Israel	746	Jewish adults	Multistage random	Degree of religiosity (Orthodox, traditional, secular)	✓ ✓	24-hr dietary recall	+ve for total fat, saturated fat, and P:S ratio in males Nonsignificant for fruit and vegetable intake	Age, region of origin, BMI, social class, seasonality
27	Hart (2004) [98]	USA	2375	Adults, >35 yrs	Random	Religious orientation (intrinsic versus extrinsic)	✓ ✓	Fat- and Fiber-Related Behavior Questionnaire	Nonsignificant for fruit and vegetable More extrinsic, less fat	Age, sex, race, education, marital status, church size
28	Hart (2006) [99]	Seattle, USA	2375	Adults, >18 yrs	Random	Cohesiveness of religious organization members	✓	Fat- and Fiber-Related Behavior Questionnaire	More cohesiveness, less fat, but nonsignificant after controlling for age and race	Age, race
29	Hart (2007) [100]	Washington, USA	1520	Adults, >18 yrs	Random	Social environmental (cohesion, leader support, order/organization, leader control)	✓ ✓	Fat- and Fiber-Related Behavior Questionnaire	More cohesion, more order/organization, more fruit and vegetable More cohesion, order/organization, lower fat	Age, race, gender, education marital status, size of religious organization

(d) Continued.

No.	First author (publication year)	Location	N	Population	Sampling method	R/S measures	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
30	Holt (2005) [101]	Missouri, USA	1227	African American women, 18–65 yrs	Convenience	Religiosity (beliefs & behavior) (i) 4 categories: low religious behavior only, belief only, high religious	√	National Cancer Institute's 5-a-day survey	Fruit/vegetable intake in descending order: Higher religious, behavior only, belief only, low religious	Education, income examined as potential covariates but not included because they are not associated with religious orientation
31	Lytle (2003) [102]	Minnesota, USA	3878	Adolescents	Random	Spiritual beliefs in health behaviors	√	Fruit and vegetable food frequency scale (from Behavioral Risk Factor Surveillance System)	Higher spiritual belief, more fruit and vegetable	Demographic & psychosocial variables
32	Obisesan (2006) [103]	USA	14,094	Nonpregnant adults, >20 yrs	Multistage random	Church attendance	√	FFQ 24-hr dietary recall	Nonsignificant	Age, sociodemogra- phic variables, health status
33	Park (2009) [104]	Hartford Hospital, USA	167	Cancer survivors, 18–55 yrs	Convenience	Religious service attendance Daily spiritual experiences Religious struggle Spiritual strain scale Mediator: Self-assurance	√	5 servings of fruit and vegetable a day	Daily spiritual experiences positively related to daily 5 servings of fruit and vegetable Self-assurance not related to 5 servings of fruit and vegetable, so no mediation test conducted	No
34	Pitel (2012) [105]	Slovakia	3674	Adolescents	Stratified random	Religiosity (religious attendance & self-rated importance of religious faith)	√	No regular fruit and vegetable consumption	Nonsignificant	Age, parental divorce, parental education, family affluence, degree of urbanization, ethnicity

(d) Continued.

No.	First author (publication year)	Location	N	Population	Sampling method	R/S measures	Dietary measures F/V Fat	Dietary assessment methods	Finding	Control variables
35	Reeves (2012) [106]	Jackson, USA	2378	African Americans	Random	Organized religious activity Private prayer Daily spiritual experiences	√	FFQ—% calories from fat	Nonsignificant	None
36	Salmoirago-Blotcher (2011) [107]	USA	71,689	Postmenopausal women, 50–79 yrs	Random	Service attendance	√	FFQ—saturated fat intake	Nonsignificant	Age, race, marital status, education, health insurance, enrollment status, physical functioning, self-rated health
37	Shmueli (2007) [108]	Israel	3056	Jews, >18 yrs	Random	Religiosity—secular, observant, religious	√	FFQ	Nonsignificant	Age, gender, education, marital status, ethnic origin, socioeconomic status
38	Underwood (2006) [109]	Midwest, USA	471	African Americans, >20 yrs	Convenience	Religious intensity/religiousness Spiritual intensity/spirituality Religious practices	√ √	Public health Service health Style self-test	Very/moderately spiritual, very/moderately religious, more collaboration—less fruit and vegetable, more fat	None
39	Wiist (2012) [110]	Web-based	811	Buddhists, >18 yrs	Convenience	Buddhist Devoutness Index (Buddhist practices & beliefs)	√ √	FFQ	Nonsignificant	Age, gender, income, disability, social support

Abbreviations:

F/V: fruit/vegetable.

FFQ: food frequency questionnaire.

P: S: polyunsaturated fat : saturated fat.

females consumed more fat. One showed no significant relationship. These five studies also examined the intake of saturated fat, and all found that Adventists consumed less saturated fat, even though their total fat intake was similar to those of non-Adventists. Three of the studies also compared the intake of unsaturated fat. Two found no significant relationship, and one found that among Adventists, the vegetarians consumed more unsaturated fat than Mormons, but Adventist omnivores consumed less saturated fat than the Mormons. Among the studies that compared unsaturated fat intake, two also looked at the polyunsaturated fat and saturated fat (P:S) ratio and found that Adventists had a higher P:S ratio.

Two of the denominational studies examined Jews. One compared the Jews with the general population in Italy and found that there was no difference in fat intake between the two groups. However, Jews consumed more animal fat than the general population. Another study compared two Jewish Hassidic sects and found that Lubavitcher Hassidim consumed more cooked fruit.

There are two denominational studies that examined fat intake in Buddhists. The study that compared Japanese Zen Buddhist monks with the general population in Japan found that Zen Monks consumed less total fat and saturated fat, more unsaturated fat, and had a higher P:S ratio. However, another study that compared Buddhist nuns with Catholic nuns found no significant difference in total fat and unsaturated fat intake, but Catholic nuns consumed more animal fat.

One study compared Mennonites with the general US population and found that the Mennonites have higher total fat, saturated fat, and unsaturated fat intake. Another one study compared Catholics with non-Catholics in Scotland and found that Catholics consumed less pure fruit juice and Catholic males consumed less fruit and vegetable.

Four studies were multid denominational. One examined fruit, vegetable, and fat intake and found no significant relationship. Three studies examined fat intake only. One found no significant association. One study found that religious denomination mediates fat intake. One showed that among females, conservative protestant and those who have no religious preferences consumed more fat than Catholics.

4.3. Degree of Religiosity Studies. A total of 25 studies were analyzed. The R/S measures were categorized into the six categories described in the previous section.

Table 4 shows the categories of R/S measures and their association with fruit and vegetable intake. The most commonly used R/S measures are multidimensional (36.8%). Among the 19 R/S measures, eight (42.1%) showed a positive association with fruit and vegetable intake and another seven (36.8%) showed no significant relationship. Among the seven measures that showed no significant relationship, four of them showed evidence of a positive trend in the relationship between fruit and/or vegetable intake.

Table 5 shows the categories of R/S measures and their association with total fat intake. The most commonly used R/S measures are institutional (40.7%). Among the 27 R/S measures, 15 (55.6%) showed no significant relationship

between R/S and total fat intake, while seven (25.9%) showed a negative relationship. Among studies that show no significant relationship, five showed evidence of a positive trend, and seven showed evidence of a negative trend.

In addition to total fat intake, three studies also examined saturated fat intake. Two studies showed no significant association. One examined the degree of orthodoxy among Jews and found that more Orthodox Jews consumed less total fat and saturated fat, more unsaturated fat, and have a higher P:S ratio.

Only 20% (5 out of 25) of the papers reported the validity of R/S measures, and 52% (13 out of 25) reported reliability of at least one of the R/S measures. Of the 12 studies that do not report reliability, three of them utilized a single-item measure of attendance. The majority of the studies (88%) controlled for covariates such as age, gender and years of education. All the studies were cross-sectional. Only one study investigated the mediator between R/S measures and healthy behaviors. However, since the mediator (self-assurance) was not associated with the intake of fruit and vegetable in the study, no further mediation test was carried out.

Table 6 shows the number of studies categorized based on their reported relationship. Of the 17 studies that examined the degree of R/S and fruit and vegetable intake, R/S reported positive association with fruit and vegetable intake in about half (52.9%) of the studies and no association in 35.3% of the studies. As for fat intake, almost half (46.7%) of the studies reported no association, and an equal number (20%) reported positive and negative findings.

5. Discussion

About half of the denominational studies compared Adventists and non-Adventists. Healthy eating is one of the major teachings in the Adventist Church; other Christian denominations (except the Church of Jesus Christ of the Latter-day Saints) do not emphasize healthy eating as much as the Adventist Church. Thus, it is not surprising to find that Adventists generally consumed more fruit and vegetable and less total fat and saturated fat than non-Adventists. Similarly in studies that compared Buddhist monks and nuns with non-Buddhists, because of the teaching of Ahimsa (do no harm), Buddhists monks and nuns are vegans, and again it is not surprising to find that they consumed less saturated fat or animal fat. A weakness of denominational studies is the assumption of homogeneity of dietary practices among the members within a denomination. Denominational studies only compared denominational differences as a whole and omitted the individual variation of R/S of members within a denomination. It is unknown whether this variation is associated with dietary intake. In addition, denominational studies are "likely to be confounded with region and the effects of socioeconomic status" [69], and almost all of the denominational studies in this review did not control for covariates.

Four of the denominational studies included samples from various Christian denominations. Three of the studies found no significant relationship between religious denomination and dietary intake. The nonsignificant findings were

TABLE 2

Categories of R/S measures	Paper no. in Table 1
Institutional	
Attendance	15, 16, 19, 32, 33, 36
Organized religious activity	35
Perceived environmental church support	20
Religious social support	15, 16, 22
Cohesiveness of religious organization members	28
Social environment	29
Religious identity	15
Ideological	
Religious beliefs and health	21
Religious application	15
Religious coping	15
Spiritual belief in health behaviors	31
Religious salience	17
Religious disagreement	17
Religious problem-solving	38
Religious struggle	33
Spiritual health locus of control	23
Religious health fatalism	25
Private devotion	
Private prayer	35
Religious orientation (intrinsic versus extrinsic)	27
Spiritual	
Daily spiritual experience	33, 35
Multidimensional	
DUREL	24
Religiosity (beliefs and practices)	30
Religious participation	17
Religiosity (attendance and self-rated importance)	34
Religious involvement index	18
Jewish religiosity	26, 37
Religious commitment	15
Buddhist devoutness index	39
Generic	
Religious intensity	38
Spiritual intensity	38

probably due to the fact that respondents from various denominations interpreted questionnaire items related to R/S differently.

Although a meta-analysis was not conducted due to heterogeneity of R/S measures and dietary measures, the present review on the relationship between degree of R/S and fruit and vegetable intake points towards a positive association; that is, a higher score of R/S is associated with higher fruit and vegetable intake. About half of the Christian studies showed a significant positive relationship with fruit and vegetable. This is consistent with the previous review that R/S is associated with a better diet [28]. The results of

the present review also suggest that the regular consumption of fruit and vegetable may be one of the possible links between R/S and positive health outcomes. Other possible links include adoption of other health behaviors such as the no smoking and drinking; better social integration and social support from religious communities; higher self-esteem and personal efficacy among the more religious; better coping resources and behaviors; positive emotions from religious practice; and healthy beliefs [42].

Six of the 17 studies reported no association between degree of R/S and fruit and vegetable intake. All three studies that included only Jewish samples showed no association. This may arise because the dietary restrictions of Judaism only revolve around meat and animal products and not on fruit and vegetable. The consumption of fruit and vegetable is neither restricted nor encouraged.

The findings for fat intake contradicted the previous review. Almost half of the studies reported no association, and an equal number reported positive and negative findings. The contradiction might be due to the fact that the previous review examined diet as a whole and not particularly fat intake. There are other studies which showed that R/S was positively associated with greater body weight [70] and obesity [71], both of which might be related to high fat intake. The proposed explanation of higher prevalence of obesity among religious people could be that religious community is more accepting towards obese people, rather than R/S itself being the cause of obesity [71]. Kim et al. [70] found that the positive relationship between R/S and greater body weight disappeared after controlling for health behaviors, particularly smoking. None of the degree of R/S studies in this review controlled for health behaviors and it is unknown whether similar attenuation effect was also found between R/S and fat intake.

Most of the studies in this systematic review included samples that were from the USA and Western countries where Christianity is the predominant religion; only two studies were conducted in Asia and one in Africa, even though religion is considered important by most people on these two continents [14]. None of the studies examined Hinduism and Islam, the two major religions in the world besides Christianity. Only three studies examined Buddhists; however, they were Buddhists in the USA rather than in Asia, even though there is a higher percentage of Buddhists in Asia.

The most frequently used dietary assessment methods were brief dietary assessments. However, they are crude estimates of dietary intake. For example, the Fat- and Fiber-Related Behavior Questionnaire does not report dietary intake per se but only an overall score of fruit and vegetable and fat intake. Dietary records are considered the "gold standard" of dietary assessment methods [68]. However, only two studies in this review utilized dietary records. No studies used dietary history, probably because they are cross-sectional and assessing dietary history is time-consuming.

The present review also showed a diversity of R/S measures used. Even within a category (see Table 2), there was variation. For example, the R/S measures coded as "institutional," defined as "measures that focused on the social and behavioral aspects of R/S" [65], included attendance and

TABLE 3: Dietary assessments of fruit and vegetable and fat intake.

Dietary assessment methods	Fruit and vegetable		Fat	
	Total	%	Total	%
Dietary records	0	0	2	7.4
24-hour dietary recall	2	6.9	6	22.2
Food frequency	8	27.6	9	33.3
Brief dietary assessments	19	65.5	10	37.0
Dietary history	0	0	0	0
Total	29	100.0	27	100.0

TABLE 4: Categories of R/S measures and fruit and vegetable intake.

Categories	Relationships				Total	%
	+	-	Mixed	None		
Institutional	4	0	0	1	5	26.3
Ideological	1	1	1	1	4	21.1
Personal devotion	0	0	0	0	0	0.0
Existential	1	0	0	0	1	5.3
Multidimensional	2	0	1	4	7	36.8
Generic	0	0	1	1	2	10.5
Total	8	1	3	7	19	100

Mixed: when an R/S measure is positively associated with fruit intake and negatively associated with vegetable intake or vice versa, or when a R/S measure is positively/negatively associated with fruit intake and not associated with vegetable intake or vice versa.

TABLE 5: Categories of R/S measures and total fat intake.

Categories	Relationships				Total	%
	+	-	Mixed	None		
Institutional	2	0	1	8	11	40.7
Ideological	0	3	1	2	6	22.2
Personal devotion	1	0	0	1	2	7.4
Existential	0	0	0	1	1	3.7
Multidimensional	0	2	0	3	5	18.5
Generic	0	2	0	0	2	7.4
Total	3	7	2	15	27	100

Positive (+) relationship: a higher score of R/S measure is associated with lower fat intake; negative relationship (-): a higher score of R/S measure is associated with higher fat intake.

Mixed: when an R/S measure is both positively and negatively associated to fat intake.

TABLE 6: Categories of studies.

Dietary intake	Relationships				Total
	+	-	Mixed	0	
Fruit and vegetable	9	1	1	6	17
Fat	3*	3*	2	7	15

Notes: * positive (+): a higher score of R/S measure is associated with lower fat intake; negative (-): a higher score of R/S measure is associated with higher fat intake.

religious social support, which are two different concepts that warrant further categorization.

Because of the diversity of R/S measures and that different R/S measures show different effects in different populations, it was proposed that R/S should be treated as a multidimensional construct [69]. However, less than a third of the R/S measures included in the present review are multidimensional.

Very little information was provided with regard to the psychometric properties of the R/S measures. In this review, only 20% of the papers reported validity and 52% reported reliability of at least one R/S measure. However, only three studies (out of 25) used single-item measures of religious attendance. The overall quality of the degree of R/S studies was mixed, most of the studies control for covariates, but none of them used longitudinal data and only one attempted mediation analysis. All the studies were cross-sectional; thus the inference of causal relationship between R/S and fruit, vegetable, and fat intake could not be established. In R/S and health research, there are very few experimental studies, and the wide use of cross-sectional data is another major drawback, in addition to lack of clear definition of R/S [39].

There are several limitations in this review. Only peer-reviewed studies that are published in English were included. This could be the reason why most studies in this review were from Western countries and included mostly Christian samples. Second, unpublished studies were excluded and this might lead to publication bias, since studies with significant results are more likely to be published. Nonetheless, the present review was the first that examined the relationship of R/S with specific dietary intake.

The contradictory findings among the studies of degree of R/S point to the need for more studies that control for health behaviors, for example, smoking, and use more rigorous dietary assessment method. In addition, more studies are needed that include participants of other religions, especially those of Eastern traditions and from non-Western countries. There is also a need to use more rigorous R/S measures that are validated, reliable, and multidimensional.

6. Conclusion

Overall, the denominational studies showed that religious denomination is significantly related to fruit, vegetable, and fat intake. Specifically, the Adventists consumed more fruit and vegetable and less fat than non-Adventists. However, the relationship between the degree of R/S and dietary intake is mixed. The results of this review suggest that future research on R/S and diet may help explain the possible mechanism between religion and health. Methodology more sophisticated than observational studies is required. Longitudinal study methodologies (while still often observational) may enhance our understanding of underlying mechanisms. As religion is important for many people and affects their diet, improved methodological quality of R/S and diet research will surely shed more light on this area.

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2.1.2. Religion, Spirituality and Other Dietary Measures

[This section relies substantially on the following paper:

Tan, M.M, Chan, C.K.Y & Reidpath, D.D. (2013). Faith, food, and fettle: Is individual and neighbourhood religiosity/spirituality associated with a better diet? Religions 5, 801-13.

For the full paper, see [Appendix O.1](#)]

Six of the 25 studies on degree of religiosity in the systematic review and a handful of other studies also examined the relationship between religiosity and other dietary measures besides fruit, vegetable and fat intake. A wide range of dietary measures were used, which included fish intake (Obisesan et al., 2006), nutritional risk (Locher et al., 2005); composite dietary index (Sahyoun & Zhang, 2005; Wallace & Forman, 1998); validated nutritional/dietary quality scale (Chliaoutakis et al., 2002; Homan, 2010; Reid & Smalls, 2004; Rew et al., 2007); dietary restriction (Rabinowitz et al., 2009); eating habits measured by food frequency questionnaire (Shmueli & Tamir, 2007) and 24-hour recall and/or food record (Kim et al., 2008; McIntosh & Shifflett, 1984); frequency of weekly fast food consumption (Benjamins, 2012; Dodor, 2012); regular breakfast (Benjamins, 2012; Pitel et al., 2012); sweets intake (Pitel et al., 2012); practicing a vegetarian diet (Wiist et al., 2012); meat intake (Underwood & Powell, 2006); and soft drink consumption (Benjamins, 2012; Pitel et al., 2012).

Consistent with previous reviews (Groen & Heide, 1959; Koenig et al., 2012; Koenig et al., 2001; Sarri et al., 2006; Shatenstein & Ghadirian, 1998) and the review on the degree of religiosity and intake of fruit and vegetable (Tan et al., 2013), the studies of religiosity and other dietary measures also pointed towards a positive direction,

where a higher level of religiosity is associated with a better diet. The majority of the studies reported positive relationship between religiosity and at least one dietary measure – religiosity is positively associated with an increased fish intake (Obisesan et al., 2006; Shmueli & Tamir, 2007), regular breakfast (Wallace & Forman, 1998) and lower soft drinks consumption (Pitel et al., 2012) among adolescents, healthful nutrition (Chliaoutakis et al., 2002; Homan, 2010; Reid & Smalls, 2004), healthy food choices and eating patterns (Rew et al., 2007), *less* dietary restriction (eating less than two meals a day) among the female Latinas caregivers of older adults with dementia (Rabinowitz et al., 2009).

A few studies that examined the relationship between religiosity and diet indirectly using other measures also showed a positive association between religiosity and diet. In the Third National Health and Nutrition Examination Survey in the U.S. of 3194 elderly, religious attendance was included as one of the five measures of social contact, and it was found that elderly with four or more social contacts have better healthy eating index than those with fewer than four social contacts (Sahyoun & Zhang, 2005). In another study, also conducted in the U.S, of 1000 elderly by the University of Alabaman at Birmingham, religious attendance was one of the measures of social capital measure; and among African American men, not attending religious services regularly was associated with higher nutritional risk (Locher et al., 2005).

By contrast, a small number of religiosity and diet studies showed a negative association between religiosity and diet. For example, in the 2004 Survey of Texas

Adults of 1504 adults, a negative association was found between religious attendance and diet quality, *i.e.*, a monthly religious attendance was associated with reduced odds of sound diet quality (Hill et al., 2006). Three religiosity and fat intake studies also showed that a higher level of religiosity is associated with higher fat intake (Tan et al., 2013). Some studies reported mixed association between different dimensions of religiosity and diet, for example, in the study of 3620 African Americans adults aged 28–34 years, those who prayed regularly and placed more importance in religion were more likely to consume fast food, while those who attend religious services more were less likely to consume fast food (Dodor, 2012).

Some religions and diet studies reported no significant relationship between religiosity and diet. In a study of 351 Jewish adolescents from a Jewish community in Chicago, self-reported religiosity was not associated with regular breakfast and soft drink and fast food consumption (Benjamins, 2012). In a longitudinal study of 351 elderly women from Allegheny County, Pennsylvania, there was no association between level of spirituality and diet (Harvey, 2008). Seven out of the 12 studies on religiosity and fat intake showed no significant relationship (Tan et al., 2013). A web-based study of 886 Buddhists in the U.S also found no association between Buddhist devoutness and adopting a vegetarian diet (Wiist et al., 2012). The conflicting results in religiosity and diet studies imply that the relationship between religiosity and diet might not be straightforward and more careful considerations are needed to understand this relationship.

The majority of the studies that reported positive association used more than one dimension of religion. In contrast, the study that reported negative association or no relationship used either the one-item religious attendance measure or one-item religious belief about healthy eating. This could be the reason for the negative and non-significant associations between religiosity and diet.

2.2. Social Gradient and Health

[This section relies substantially on, and incorporates a published paper on social gradient and dietary habits (Tan et al., 2016)]

Socioeconomic status (SES) is a strong predictor of health, and individuals with higher SES tend to have better health than those with lower SES. This health inequality is found not just at the threshold of poverty, but also at every level of the SES hierarchy (Lundberg & Cooper, 2011). The SES-health gradient has been associated with many major diseases and conditions including cardiovascular diseases (Braveman et al., 2010), type II diabetes (Kavanagh et al., 2010), many cancers (Ward et al., 2004) and arthritis (Canizares et al., 2008).

At the individual level, SES is usually measured by one or more of three inter-related but not fully overlapping indicators: education, occupation and income (Shavers, 2007). In earlier epidemiology studies, SES was usually included as a control or confounding variable instead of the independent variable of direct interest (Adler & Ostrove, 1999). Over the past few decades the impact of SES on health has become a direct focus of attention in health research (Braveman et al., 2005).

Behavioral factors are a significant contributor to many NCDs (World Health Organization, 2014), and there is considerable evidence showing that SES is associated with health behaviors. People with lower SES are more likely to smoke (Laaksonen et al., 2005; Winkleby et al., 1992), less likely to be physically active (Giles-Corti & Donovan, 2002; Powell et al., 2004) and more sedentary (van Sluijs et al., 2008).

SES appears to influence health indirectly through lack of access to health care, environmental exposure, and effects on behavior and lifestyle, which contribute to about 80% of premature mortality; and among them, behavior and lifestyle account for about half of the premature mortality (Adler & Newman, 2002; McGinnis & Foege, 1993).

SES is also associated with dietary behaviors. Compared with those with high SES, individuals with low SES consume less fruit and vegetable (De Irala-Estevez et al., 2000; Giskes et al., 2002; Johansson et al., 1999), more added fat (Linseisen et al., 2002), and less whole-grain food (Lang et al., 2003). Unhealthy diet is a major contributor to the development of non-communicable diseases (NCDs), which are responsible for 63% or about 36 million deaths globally (World Health Organization, 2003, 2009). The diet-related health disparities due to SES reflect not just differences in dietary intake and behaviors, but also differences in the prevalence, mortality, morbidity and burden of diet-related diseases across social gradient (Satia, 2009).

2.3. Neighbourhood and Health: A Multilevel Approach

[This section relies substantially on the following paper:

Tan, M.M, Chan, C.K.Y & Reidpath, D.D. (2013). Faith, food, and fettle: Is individual and neighbourhood religiosity/spirituality associated with a better diet? Religions 5, 801-13.

For the full paper, see [Appendix O.1](#)]

Neighbourhood and health is a relatively new research field which emerged during the late 1980s and early 1990s and has grown exponentially during the last 10-15 years (Diez Roux & Mair, 2010). However, the study of neighbourhood and health has a long history. In *On Airs, Waters, Places*, one of the writings in Hippocratic Corpus, a collection of ancient medical texts written largely between fifth and fourth centuries BC, the physicians are advised to consider the seasons of the year, the warm and the cold winds, and the effect of water on health while examining patients (Hippocrates). In the mid-eighteenth century A.D in Europe and in European colonies, probably due to increased urbanization, there had been a rise of interest in medical topography, “the systematic surveying, mapping, charting, and description of specific geographical sites, with reference to the physical features that were presumed to influence health and disease” (Macintyre & Ellaway, 2003; National Library of Medicine, 2015). The civil registration of births and deaths in also enabled the flourish of medical topography. For example, in a longevity study in England in the nineteenth century A.D., it was found that people in the top social stratum live longer than those from the middle and lower strata, and there were geographical variations such that there was even a longevity gradient within the same stratum depending on the locations (Chadwick, 1842).

One of the main reasons to study neighbourhood and health is that the neighbourhood variations in health and health behaviours have been well documented (Pickett & Pearl, 2001; Stafford & Marmot, 2003), and many studies have shown that the places one lives influences his or her health. The earliest studies in neighbourhood and health were those of all-cause mortality. It has been found that mortality is significantly higher in deprived neighbourhoods after adjustment for individual characteristics such as age, gender and race (Anderson et al., 1997; Haan et al., 1987). In other studies, it was also found that increased availability and access to a supermarket was positively related to healthier diet and a lower risk of obesity; and an increased availability of health food in supermarket was associated with a healthy diet. (Larson et al., 2009). The presence of more fast food restaurant was associated with poorer diet (Moore et al., 2009). In areas with better resources for physical activity, there was a higher prevalence of physical activity and a lower risk of obesity (Papas et al., 2007), indicating the role that neighbourhood may play in shaping health protective behaviours.

Generally it has been thought that health is a personal responsibility; an individual's health is dependent on his or her choices (Minkler, 1999). Indeed, numerous studies have shown that people who adopt a healthy lifestyle enjoy a better health and longer lifespan. However, the "personal responsibility" paradigm ignores the social contexts within which people make decisions. There are circumstances when they may be unable to choose a healthy lifestyle. For example, those who live in an area that lacks of resources for exercise are more

likely to not exercise (Booth et al., 2005). Thus, individual-based explanation of health and illness are insufficient. It is now recognized that an individual's broader social environment has an effect on health, illnesses, and health behaviours, hence the increased interest to study neighbourhood and its influence on health (Diehr et al., 1993).

The geographical variations in health (mortality, morbidity) and health behaviours could have two possible explanations: a compositional explanation, where the differences in health outcomes are due to the different kinds of people living within a neighbourhood (individual effect), and a contextual explanation, where the differences are due to differences between places/area/neighbourhood (contextual effect) (Macintyre & Ellaway, 2003). For example, in a poor neighbourhood, the high prevalence of poor dietary behaviours could be caused by the people choosing to behave badly, or it could be caused by limited access to healthy food choices within the neighbourhood. Compositional or contextual explanation for health outcomes affects the health promotion methods. Compositional explanation might lead to more research and policies targeting on individual factors, while contextual explanation might lead to more actions on health-promoting or health-damaging characteristics of a neighbourhood (Ellaway & Macintyre, 1999).

2.3.1. Religious Neighbourhood and Health

Even though religion is practiced individually, it is also a community activity, and each religious community is a miniature neighbourhood by itself where adherents of the same faith gather regularly and interact with each other. Similar to other

neighbourhoods, different religious communities also vary in socioeconomic status (SES), racial proportions, education etc. In addition, there is a variation in the degree of adherence to religious norms in different religious communities even within the same religion. Thus, as in other neighbourhoods, the physical and social characteristics of a religious community might influence the health and health behaviours of its members.

There are numerous of social science studies that examined religious neighbourhood. In one study it was found that living in a Protestant neighbourhood increased moral trust regardless of the individual's religions (Traunmuller, 2011). In another study it was found that individual and congregational characteristics influenced social justice prioritization and participation differently (Todd & Allen, 2011). Another related study also showed that individual and congregational variables predict differently personal social justice participation through and outside the congregation (Houston & Todd, 2013).

However, very few studies explored the relationship between a religious neighbourhood and health. In one study, Israeli Jewish men and women living in more religiously affiliated neighbourhood were found to have a lower mortality rate than that of secular neighbourhood, even after controlling for socioeconomic status, age, country of origin, marital status, and education (Jaffe, 2005). For women, the effect was observed only in those from low and medium SES-areas.

These results in social science and health studies marked the significance for taking into account the potential effect of neighbourhood/congregational characteristics in understanding the relationship between religion and health outcomes.

Another overlooked religious neighbourhood is the “congregation”. The past studies on religious neighbourhood and health examined neighbourhood where people from different religions lived together. Congregations, on the other hand, are places where people from the same faith gather together. Even though there might be variations of religious adherence, the majority of the congregants of a particular congregation share the same faith. Different congregations have different congregational characteristics such as size, conservativeness, gender compositions, age group etc. that might influence health and health-related outcomes. In this study, the neighbourhood was defined in the context of congregation and the congregational characteristic that was being examined was congregational conservativeness.

Similar to “neighbourhood effect” on health and health behaviours within a neighbourhood, within a congregation, there might be a “congregational effect” on health behaviour, such as dietary practices, among the congregants over and above individual factors such as individual religiosity. For example, even though it is part of the Seventh-day Adventist doctrine that vegetarian diet is the original diet intended by God and Adventists are encouraged to consume more fruit and vegetable, different Adventist congregations might have different level of

adherence to Adventist doctrine (conservativeness), and hence exhibit different congregational level of observance of Adventist dietary practices. The different level of congregational observance might influence the level of observance of the individuals attending that particular congregation. Are less adherent members more likely to have a healthier diet if they are members of adherent congregations than less adherent members who are members of less adherent congregations?

2.3.2. Multilevel Modelling

The study of contextual effect is multilevel analysis, which “seeks to explain individual outcomes in terms of both individual and environmental or aggregate variables” (Von Korff et al., 1992). Multilevel analysis allows for the separation between individual and contextual effects and simultaneous examination of individual- and contextual-level variables on individual-level outcomes. It has been used in public health to study alcohol and drug abuse (Duncan et al., 2002; Snedker et al., 2009), smoking (Moore et al., 2001) cardiovascular risk factors (Sundquist et al., 1999), domestic violence (Gracia & Herrero, 2006).

Further details on multilevel modelling is found in Chapter 3.6.6.

2.4. Who are the Seventh-Day Adventists?

The target population of this study was the Seventh-day Adventists in West Malaysia. The Seventh-day Adventist Church, established in 209 countries, is a conservative Protestant denomination with a worldwide membership of about 17 million (Office of Archives, 2010). The Adventist Church shares many of the mainstream Christian denominations’ doctrines, such as the Trinity, baptism and

Holy Communion. One of the main characteristics that distinguish the Adventist Church from other denominations is its observance of Saturday as the Sabbath instead of Sunday.

The Adventist Church was first established in 1863, during the period of the health reform movements in the U.S. In the nineteenth century U.S., many people were disillusioned with orthodox medicine, which cared little about prevention of diseases. Ellen G. White (1827-1915), one of the founders of the Adventist Church, was one of the health reformers in the U. S. In her writings she stated that a person's spirituality is affected by his/her physical health, thus it is important to maintain one's health by adopting a vegetarian diet, exercising, and getting sufficient sunlight, fresh air, and clean water (White, 2001). She also highlighted the sanctity of the body, guided by the biblical idea that the body is "a temple of the Holy Spirit" and one should "honour God with your body" (1 Corinthians 6:19-20, New International Version).

Because of White's advice, since the Church's establishment healthy lifestyle has been one of the Adventist core messages. According to the doctrine, smoking, alcohol and drugs are prohibited. In addition, Adventists are discouraged from consuming caffeinated beverages such as coffee, Coca-Cola, and tea. Adventists observe the dietary law according to Leviticus 11 and Deuteronomy 14 of the Bible – only "clean" meat is consumed, which includes that of mammals that have divided hooves and chew the cud (the ruminants), and fish that have scales and fins. Other meat, such as pork and shellfish, are considered unclean. The

Adventist Church believes that the original diet intended by God was vegetarian, and members are encouraged to be vegetarians; “I give you every seed-bearing plant on the face of the whole earth and every tree that has fruit with seed in it. They will be yours for food (Genesis 1:29, New International Version).

Numerous studies have been carried out among Adventists starting in the 1950s to investigate the relationship between lifestyle and health. Largely because of their distinct lifestyle, Adventists enjoy a better health and longer life span. The Adventist community in Loma Linda, California, is one of the five “blue zones” in the world, where a substantial number of centenarians were found (Buettner, 2005, 2012).

2.4.1. Major Health Studies of Adventists

2.4.1.1. Adventist Mortality Study

The Adventist Mortality Study (AMS) was the first major cohort study of Adventists, conducted from 1958-1966 (Fraser, 2003). The aim of the study was to determine the causes of death and mortality rates of Adventists. A total of 22,940 White Adventists above 25 years old from California were followed up intensively for 5 years, then informally for the next 25 years. Each participant filled in a questionnaire about their lifestyle and diet at the beginning of the study and mortality was monitored.

Compared with the California population, the California Adventists had a lower mortality rates after controlling for ethnicity and socioeconomic status. The all-

cause mortality rate of Adventist males was 64.9% of the general California population, and all-cancer mortality rate, 70.6%, and for Adventist females, 74.1% and 80.1% respectively (Lemon et al., 1963). The mortality rates of liver cirrhosis in both sexes were also lower than that of California population– 14% for Adventist males and females. The California Adventists experienced a moderate but non-significant reduction in mortality rates in cancer of stomach, intestine and rectum, urinary system and lymph and all other cancers for both sexes; prostate and genital cancers for males; and breast, cervical and uterine cancers for female (Lemon et al., 1963).

The AMS was carried out simultaneously with the American Cancer Society (ACS) mortality study of non-Adventists, who were compared with the Adventists. Smoking rate was low among Adventist; only 1.7% of Adventist males and 0.5% of Adventist females were current smokers, compared with 51.4% of non-Adventist males and 32.0% of non-Adventist females, and there were three times more Adventist males than non-Adventist males and 1.5 times more Adventist females than non-Adventist females who have never smoked before (Phillips et al., 1980). One of the major findings of the AMS was the low mortality rate of cancer of the lung and mouth for Adventist males. In California male population, lung cancer was the top cause of cancer (13.8% of all deaths in California men), while in Adventist males, the disease only ranked 6th or 7th (5.8% of all deaths in Adventist men) (Lemon et al., 1963). Ten (7 males, 3 females) of the 14 Adventist individuals in the AMS who died of cancer of the lung, mouth, or larynx have been regular tobacco users before joining the Church. All the seven men were recent

converts and smoked regularly between 28-49 years, including one who was smoking up till his death (Lemon et al., 1963).

To eliminate the confounding effect of smoking, the researchers compared non-smokers from the ACS study and the AMS. For lung cancer, the risk of dying of Adventists was half of that of the non-smoking ACS study participants; and for colon-rectal cancer, the mortality risk was also significantly lower (Phillips et al., 1980). Compared with non-smoking non-Adventist males of ACS study, the Adventist males has a lower mortality rate of all causes combined, coronary heart disease, and stroke (Phillips et al., 1980). The post-menopausal breast cancer mortality of Adventist females was 81% of the non-Adventist females (Phillips et al., 1980).

Another important finding of AMS vs. ACS study was that adherence to Adventist lifestyle is inversely related the risk of fatal lung, colon-rectal, stomach cancers in males and females, and coronary heart diseases in males after controlling for smoking (Phillips et al., 1980). Even though non-smokers non-Adventists have more similar mortality rates as the Adventists, there were still health benefits of Adventist lifestyle not accountable by smoking status. The Adventist lifestyle also seemed to be more protective for males more than females. The results of AMS raised another question – which part of Adventist lifestyle is conducive to health?

2.4.1.2. Adventist Health Study-1

From 1974 to 1988, a prospective cohort study of Adventists was conducted: the Adventist Health Study-1 (AHS-1). The purpose of the study was to determine which lifestyle factors contributed to differences in health outcomes among the Adventists. It compared Adventists with different dietary practices, rather than with the general population. Even though Adventists are encouraged to be vegetarians, it is not compulsory. As a result, there is a wide range of dietary practices among the Adventists. There were 29.5% vegetarians (those who did not consume meat at all), 21.2% semi-vegetarians (those who consumed meat less than once a week), and 49.2% non-vegetarians (Fraser, 1999).

A total of 34,198 non-Hispanic, white California Adventists ages 25 and above were followed up for eight years (1975-1982) for all-cause-mortality and six years (1977-1982) for cancer incidence and ischemic heart disease (Beeson et al., 1989). In addition to mortality, AHS-1 also looked at non-fatal cases of cancer and heart disease and examined in more detail the diet of Adventists.

Compared with non-vegetarian Adventists, vegetarians Adventists consumed more fruit, legumes, tomatoes and nuts but much less coffee, donuts and eggs, were more likely to prefer whole-grain bread and 20 times less likely to consume alcohol than non-vegetarians (Fraser, 1999). The Adventist vegetarians, semi-vegetarians and non-vegetarians consumed similar amount of fat; however, the vegetarian Adventists had a higher polyunsaturated to saturated fat ratio (0.83 in vegetarian and 0.63 in non-vegetarians).

The AHS-1 showed that a vegetarian diet is beneficial to health. Across the dietary groups, from vegetarian to non-vegetarians, there was a significant increased risk of obesity, diabetes, hypertension, rheumatoid arthritis and rheumatism for males and females after adjustment for age (Fraser, 1999). In males, those who consumed beef more than three times a week had a relative risk of fatal ischemic heart disease (IHD) of 2.31 compared with vegetarians, but the effect was not seen in women (Fraser et al., 1992). Regular nut and whole wheat bread consumption was also associated with lower risk of fatal and non-fatal IHD (Fraser et al., 1992).

The AHS-1 also found dietary association of various cancers. The risk of prostate cancer was 54% greater in non-vegetarians and the lower risk among vegetarians is associated with the high consumption of dried fruit and low consumption of fish (Mills et al., 1989). The risk of colon cancer increased 88% among non-vegetarians and was associated with red and white meat consumption while legume consumption was protective against colon cancer among those who ate red meat. Those who consumed meat more than three times a week had a two-fold increase in the risk of bladder cancer (Mills et al., 1991). For pancreatic cancer, the consumption of dried fruits, legumes and vegetarian meat were protective (Mills et al., 1988). The consumption of fruit was also negatively associated with lung cancer (Fraser et al., 1991). However, the dietary association of breast cancer was unclear. No food is associated with the disease (Mills et al., 1989).

The vegetarian females, on average, lived 2.52 years longer than non-vegetarian females, and vegetarian males, on average, lived 3.21 years longer than non-vegetarian males (Fraser & Shavlik, 1999). Overall, compared with the California population, on average the Adventists men live 7.3 years long and Adventist women live 4.4 years longer (Fraser & Shavlik, 2001).

2.4.1.3. Adventist Health Study-2

In 2002, the Adventist Health Study-2 (AHS-2) was launched. This was one of the largest and most comprehensive cohort studies of diet and cancer and included 96,000 Adventists in the U.S and Canada, aged 30 and above. Among the study population were about 26,000 African American, making the AHS-2 the largest health study of African Americans. The aim of AHS-2 was to investigate the role of various food and nutrients and their relationship with the development of cancer (Butler et al., 2008).

In AHS-2, the categorization of dietary subgroups was more specific than it was in AHS-1. There were five subgroups: vegans (total abstinence from animal products, 4.2%), lacto-ovo vegetarians (consume eggs and/or dairy products but not meat, 31.6%), pesco-vegetarians (consume fish but no other meat, 11.4%), semi-vegetarians (consume meat less than once a week, 6.1%) and non-vegetarian (consume meat more than once a week, 46.8%) (Butler et al., 2008). The non-vegetarians consumed only one-third of the quantity of fruit and vegetable compared with the vegetarians.

According to the preliminary results, across the dietary practices from vegans to non-vegetarians, there was an increased risk of diabetes (Tonstad et al., 2009), obesity (five units difference in BMI) and hypertension (Pettersen et al., 2012). Compared with non-vegetarians, all the other vegetarian diets had better metabolic risk factors profile (which includes measurements of HDL, triglycerides, glucose, blood pressure, and waist circumference) and were at a lower risk of metabolic syndrome, a cluster of disorders that are associated with increased risk of diabetes and cardiovascular diseases (Rizzo et al., 2011).

As for specific food and relationship with diseases, the AHS-2 found that increased consumption of cooked green vegetable, legumes, dried fruit, and brown rice reduced the risk of rectal-colon polyps, the precursors to colorectal cancer (Tantamango et al., 2011). There was also a dose-response effect.

The Adventist Religion and Health Study (ARHS), a sub-study of AHS-2, was started in 2006 to examine how different dimensions of religion are associated with physical and mental health. About 11,000 of the participants from AHS-2 answered questionnaires about religiosity, exposure to stressor, psychological characteristics and social life (Lee et al., 2009). About 530 of the 11,000 participants were recruited to provide their saliva sample, a 12-hour overnight urine sample, fasting blood and adipose samples, and to assess their biometrics, percentage of body fat, and physical performance. They also filled in questionnaire on physical and cognitive functions (Lee et al., 2009).

The ARHS preliminary results showed that recent divorce is positively associated with increased depressive symptoms, and the styles of positive religious coping buffer the deleterious effects of divorce on depressive symptoms (Webb et al., 2010). The study also examined Sabbath-keeping, an important doctrine in the Adventist Church. It was found that religious coping, religious support, diet and exercise partially mediated the relationship between Sabbath-keeping and positive physical and mental health (Superville et al., 2014).

2.5. Summary

Based on the literature review, there is a paucity of single-denominational studies that examine the relationship between religion/spirituality and health and health behaviours at individual and congregational levels. Little is known whether social gradient still exists in a health-conscious population. From the evidence presented in the review, the majority of the available studies point towards a positive association between religion/spirituality and dietary behaviours. A cross-section survey was conducted to answer the research questions, as described in the next chapter.

CHAPTER 3: METHODOLOGY

The aim of this study was to understand the relationship between religion/spirituality and health. Specifically, it is to examine the relationship between individual religiosity and congregational characteristic and individual diet. In addition, this study also examined whether social gradient exists in the dietary habits of the participants and whether health behaviours mediate the relationship between religiosity and health. This chapter describes the methodology used to answer the research questions raised in Chapter 1. Table 1 shows the methods of investigation for each research objective and its relevant research question, and in which chapter of this thesis the results are reported.

Table 1. Research objectives and their corresponding research questions, methods of investigation and chapters where the results are reported.

Study	Research Objective	Research Question	Methods of Investigation	Result Chapter
1	To understand the relationship between individual religiosity and healthy diet	What is the relationship between individual religiosity and diet among Seventh-day Adventists in West Malaysia?	Multiple linear and logistic regressions	5
2	To identify whether social gradient still exists in the dietary habits of a health-conscious population	Does the social gradient remain in the dietary habits of the Seventh-Day Adventists in West Malaysia?	Multiple linear regressions	6
3	To identify whether the composition of religious congregations had an effect on individual diet above and beyond the individual effects of religiosity	Does congregational conservativeness predict individual diet over and above individual factors (religiosity and demographics)?	Multilevel linear and logistic regressions	7

4	To understand the relationship between religiosity, health behaviours, and measurable health outcomes	Do alcohol consumption, dietary habits and exercise mediate the relationship between individual religiosity and health outcomes among the Seventh-day Adventist in West Malaysia?	Path analysis	8
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There are seven sections in this chapter. The first section describes the sampling frame and sample of this study. The second section discusses how the participants of this study were recruited. The third section describes the procedure of the study. There were two surveys and a health screening. The fourth section describes the measures used in this study. The fifth section describes the translation of the questionnaires. The six section includes the pilot testing of the questionnaires. The last section includes the statistical analyses of the data. Multiple regressions were used to examine the relationship between individual religiosity and diet and whether social gradient existed in the dietary habits of the participants; while multilevel regressions were used to examine the influence of congregational conservativeness on individual dietary habits. Mediation analysis was used to study whether health behaviours mediated the relationship between religiosity and health.

3.1. Sampling Frame and Sample

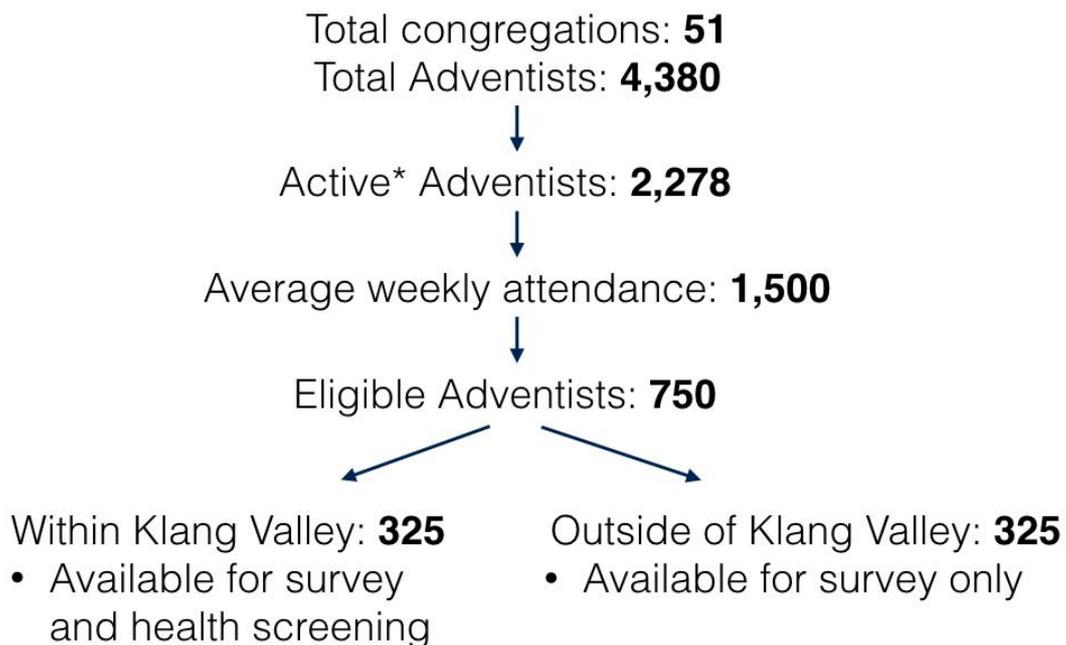
The Adventist missionary work in Malaysia commenced in the 1890s, when American Adventist missionaries were sent from Singapore to Kuala Lumpur, Malaya (as West Malaysia was known at that time) (Peininsular Malaysia Mission,

2014). On 1 July 1914, the Federated Malay States Mission, the mission branch of the Adventist Church in West Malaysia, was organized and it was under the commission of Singapore Adventist Mission. After a few relocations, the Federated Malay States Mission set up its office at Jalan Bukit Bintang, Kuala Lumpur, where it would remain until 1996 and moved to Jalan Kuchai Lama, Kuala Lumpur. The next town where Adventist missionaries were sent was Penang, and the Adventist Mission Clinic, which later would become Penang Adventist Hospital, was established on 12 December 1924. On 1 January 1988, the Federated Malay States Mission began to operate independent of the Singapore Adventist Mission and was known as Peninsular Malaysia Mission (PMM).

The sampling frame for the studies was all baptized Seventh-Day Adventists who are residing at West Malaysia. According to PMM, the number of baptized Adventists was 4,380 in 2013 when the current study was commenced, and the total number of congregations is 51 (see [Appendix A](#) for the list of congregations). Congregations range in size from 10 to 200 members, with an average yearly baptismal/conversion rate (joining the Adventist Church) of 136 over the past five years. Out of the 4380 members, 2,278 are active i.e. they attended church more than twice a month. Eligible participants for this study were baptized Adventists aged 18 years and above and were residing in West Malaysia. The average total attendance on a given Saturday worship of all congregations in West Malaysia was about 1,500, of whom about 50% were eligible participants for this study (the other 50% included children below 12 years old, adolescents between 12-18 years old, Adventists who were not residing in West Malaysia and non-Adventists). That

is, there was an estimated 750 potential participants available for the study. Figure 1 is a summary of the number of eligible participants of this study.

Figure 1. The number of eligible participants.



*Attend service more than twice a month

There are three types of Adventist congregations: group, company, and church. A group has fewer than 20 members; a company, fewer than 36 members but greater than 20; and a church, more than 36 members. Table 2 is the summary of the number of congregations according to language of worship (see [Appendix A](#) for the list of congregations).

Table 2. Number of congregations in PMM stratified by languages and types of congregation.

Language	Group	Company	Church	Total
Chinese	2	2	8	12
English	4	2	10	16
Malay	3	2	2	7
Tamil	3	4	9	16
Total	12	10	29	51

3.2. Recruitment of Participants

Ethics approval was sought from Monash University Human Research Ethics Committee (MUHREC) (see [Appendix B](#)). Permission to conduct the research was sought from PPM and granted (see [Appendix C](#) for endorsement letter issued by PMM). An introduction of the research was made during an annual PMM pastors' meeting on 22 January 2013 and 21 January 2014. The pastors were briefed about the purpose of the study and how it would be conducted.

The pastors, or elders in the case of congregations that had no pastors, were contacted personally for permission to conduct the research at their congregations. After permission was obtained, weekly recruitment announcement was made during worship services for at least one month. A Facebook page was created to promote the research and provide updates to the participants (see [Appendix D](#)). In addition, eligible participants were contacted personally by the researcher through social media such as WhatsApp, email, and Facebook Messenger.

3.3. Procedure

This study used a cross-sectional survey design. There were two surveys; the first was congregational and the second, individual. One congregational survey was completed by the pastor or elder for each participating group, company or church. One individual survey was completed by each participant. A subset of the Adventists from the individual survey also participated in a healthy screening.

In the first survey the pastors or elders were given an explanatory statement (see [Appendix E](#)) and a questionnaire about congregational conservativeness (see [Appendix F](#)). In the second survey, eligible Adventists were given an explanatory statement (see [Appendix G](#)) and a questionnaire (see [Appendix H](#)) that included items about religiosity, diet, lifestyle, self-reported anthropometric measurements and history of diabetes and raised blood pressure, and demographics. The researcher was present at the local congregations to administer and collect the questionnaires of the second survey. If the researcher was unable to be present, the local pastor or elder were trained to administer the questionnaires to the eligible participants. The returned questionnaires were posted to the researcher. Participants who completed and returned the questionnaire were given a small token of appreciation.

The online version of the questionnaire of the second survey was created using Survey Monkey and links to the survey were put onto the Facebook page of the study. Link to the online questionnaire were also sent directly to eligible

Adventists through social media such as WhatsApp, LINE, Viber, email and Facebook Messenger.

Seventeen congregations that were located within 100km from Monash University Sunway Campus were selected for health screening. The pastors of the congregations were asked for permission to conduct the health screening. Three congregations consented. The participants received an explanatory statement (see [Appendix I](#)) and signed an informed consent form (see [Appendix J](#)) before the health screening. During the health screening, blood pressure, blood glucose level, weight, height, BMI, and waist and hip circumferences were measured. See section 3.4 for details of the measurements. The health screening was open to all who attended the congregations on the day of the screening. However, only data from eligible participants of this study were included in the subsequent statistical analysis.

3.4. Measures

3.4.1. Congregational Conservativeness

The questionnaire for pastors/elders (see [Appendix F](#)) contained the self-assessed conservativeness of the congregation measured on a scale of 10, where a higher score indicates more conservativeness. Congregational conservativeness was included in multilevel analysis (see section 3.7.6). This variable was chosen in this study because of their importance in health. A more conservative Adventist congregation is more adherent of church doctrine regarding health and thus more likely to organize health-related activities (Tan et al., 2014).

3.4.2. Dietary Variables

Diet was measured using a dietary habits scale, a measure of fruit and vegetable intake, and self-identification of vegetarian status.

3.4.2.1. Dietary Habits

Dietary habits were measured by using the Nutrition subscale of Health Promotion Lifestyle Profile II (HPLPII), which was developed and validated by Walker et al. (1987) and contains six subscales. The Nutrition subscale contained nine items that assess various aspects of dietary habits such as choosing a low-fat, low-salt and low-sugar diet, regular consumption of fruit and vegetable, eating breakfast etc. The items were scored on a 4-point response scale (never, sometimes, often, routinely), and a higher score indicates a higher frequency. A total score for the subscale was obtained by calculating the mean of the responses to the nine items (Walker et al., 1995).

HPLPII has been used to study the health-promoting behaviours of older adults (Speake et al., 1989; Walker et al., 1988), university students in Hong Kong (Lee & Loke, 2005), employed Mexican Women (Duffy et al., 1996), and rural older women (Pullen et al., 2001). A study of the psychometric properties of HPLPII using a sample of adult Turkish population showed high internal consistency of the overall scale (Cronbach's $\alpha=0.92$) and the Nutrition subscale (Cronbach's $\alpha=0.73$); and the factors were supported by exploratory factor analysis and confirmatory factor analysis (Pinar et al., 2009). The internal consistency of the Nutrition Subscale for this study is acceptable (Cronbach's $\alpha =0.71$).

3.4.2.2. Fruit and Vegetable Intake

Fruit and vegetable intake plays an important role in health. About 1.7 million deaths worldwide are attributed to a low fruit and vegetable intake (World Health Organization, 2002). In addition, about 14% of gastrointestinal cancers, 11% of ischemic heart disease, and 9% of stroke worldwide are also attributable to low fruit and vegetable intake (World Health Organization, 2009).

Fruit and vegetable intake was measured with the fruit and vegetable intake items from WHO STEPwise Approach to Surveillance (STEPS) instrument, a tool to collect data and measure non-communicable disease (NCD) risk factors (World Health Organization, 2013b). STEPS has been used to study NCD risk factors in many countries, including Nigeria (Okpechi et al., 2013), Democratic Republic of Congo (Longo-Mbenza et al., 2008), Kenya (Bloomfield et al., 2013; Tawa et al., 2011) and India (Thankappan et al., 2010), and fruit and vegetable consumption in Mozambique (Padrão et al., 2012) Iran (Esteghamati et al., 2012) and Asia (Kanungsukkasem et al., 2009).

In this study, the participants were asked “In a typical week, on how many days do you eat fruit/vegetable?” and “How many servings of fruit/vegetable do you eat on the day you eat fruit?” A sum of fruit and vegetable intake was obtained by adding the number of servings of fruit and vegetable. The STEPS questionnaire uses generic terms for fruit and vegetable rather than a specific list of food, thus, it is necessary for the participants to know the definition of fruit and vegetable

(Agudo, 2005). As reference, pictures showing the size of servings of common fruit and vegetable were provided in the questionnaire.

3.4.2.3. Vegetarian Status

Vegetarianism is an important teaching of the Adventist Church, which believes that the original diet intended by God was vegetarian (Genesis 1: 29-30) and encourages its members to become vegetarian. In North America, the prevalence of vegetarianism among the Adventists was 35.8% (Butler et al., 2008).

In this study the participants were asked to indicate their dietary practices as vegan, lacto-ovo vegetarian, pesco-vegetarian (a person who eat fish and no other types of meat), or non-vegetarian. The vegan/vegetarian participants were also asked to indicate the duration they have been a vegan/vegetarian. This dietary classification has been used in a previous study on Adventists in Barbados (Brathwaite et al., 2003) and is based on the findings of Adventist Health Study-2 (see section 2.3.1.3), which categorized the participants based on the reported amount of foods of animal origin they consumed per month (Orlich et al., 2013).

Due to low number of vegan and vegetarian, these two categories were combined as “vegetarian” while pesco-vegetarian and non-vegetarian were combined as “non-vegetarian”.

3.4.3. Religious Variables

Four dimensions of religiosity were included in the study: religious attendance, private religious activities, intrinsic religiosity and Sabbath-keeping.

Religious attendance, private religious activities and intrinsic religiosity were measured using the five-item Duke University Religion Index (DUREL), a brief, comprehensive and low-burden measure of religiosity that is easy to use in large cross-sectional and longitudinal studies (Koenig, Parkerson Jr, et al., 1997). DUREL contains three subscales: organizational religious activity (ORA), non-organizational religious activity (NORA) and intrinsic religiosity (IR). ORA is an one-item subscale that measures the frequency of attendance of religious gathering. NORA is also a one-item subscale; it measures the frequency of private religious activities such as prayers, reading of religious literature, listening or watching religious program etc. The ORA item, together with the NORA item, have been administered to almost 7,000 adults aged 18-90 years old from the National Institute of Health clinical studies (Koenig & Bussing, 2010). The three-item intrinsic religiosity subscale measures the degree of internal religious motivation and was taken from Hoge's ten-item intrinsic religiosity scale (Hoge, 1972). The three-item subscale has acceptable internal consistency (Cronbach's $\alpha=0.75$), and correlates strongly to the Hoge's ten-item intrinsic religiosity scale and moderately with ORA and NORA (Koenig & Bussing, 2010).

DUREL has been translated into many languages such as Portuguese (Lucchetti et al., 2012), Malay (Nurasikin et al., 2010), Persian (Saffari et al., 2013), Chinese (Wang et al., 2013) and so forth. DUREL has been used in more over 100 studies (Koenig & Bussing, 2010). The two-week test-retest reliability of DUREL is high (intra-class correlation coefficient = 0.91) (Storch, Strawser, et al., 2004). The overall scale also has high internal consistency (Cronbach's $\alpha=0.91$) (Storch,

Roberti, et al., 2004), and its validity is supported by significant positive correlation with other religious scales (Plante et al., 2002; Storch, Roberti, et al., 2004).

3.4.3.1. Religious Attendance

In many early studies of religion and health, religion data were collected as “add-on” variables of a large epidemiological or social studies (Hill & Pargament, 2003; Levin, 1994). Since these studies included many variables, researchers had to relied on brief religious measure. Single-item religious attendance measure has been the most commonly used religiosity measure because of its “ease of use”, (Hall, Meador, & Koenig, 2008). The use of brief religious measure that has limit reliability might attenuate the association between religion and health, resulting in smaller effect sizes (Hill & Pargament, 2003).

Despite the limited reliability, religious attendance has been a robust predictor of many health outcomes; in most of the religion and health studies that have used a religious attendance measure, the majority have also found that it is positively associated with better health outcomes (Levin & Vanderpool, 1987); for example, it has been associated with lower mortality rates (H. G. Koenig et al., 1999; Strawbridge, Cohen, Shema, & Kaplan, 1997), better adoption of health behaviours (T. D. Hill, Burdette, Ellison, & Musick, 2006; Strawbridge, Shema, Cohen, & Kaplan, 2001), increased life’s satisfaction(Levin, Markides, & Ray, 1996) , and a lower prevalence of hypertension (Gillum & Ingram, 2006).

In this study, religious attendance is measured by the ORA subscale in DUREL with the question *How often do you attend church or other religious meetings?* The score options for ORA were: (1) More than once per week, (2) Once a week, (3) A few times a month, (4) A few time a year, (5) Once a year or less, (6) Never. The scores were reversed coded so that a higher score indicated higher attendance. Due to low number of participants in the lower range of scores, ORA was recoded into three categories: less than once per week, once per week, and more than once per week.

3.4.3.2. Private religious activities

Private religious activities include prayers, meditation, reading of religious literature, listening or watching religious programs and others. Many of the study on private religious activities and health were conducted among the elderly. In some studies they are positively associated with better survival among the elderly before the onset of physical impairment (Helm et al., 2000), lower blood pressure among the elderly (Koenig, George, Hays, et al., 1998); while in other studies elderly who conducted more private religious activities had poorer physical health (Koenig, Hays, et al., 1997), more physical impairment (Haley et al., 2001). The possible reason for the negative association could be that elderly who have poorer health tend to pray more as a form of religious coping (Ellison, 1991).

In this study, private religious activities was measured by the NORA subscale in DUREL by asking the participants *How often do you spend time in private religious activities, such as prayer, meditation or Bible study?* The score options for NORA

were: (1) More than once per week, (2) Once a week, (3) A few times a month, (4) A few time a year, (5) Once a year or less, (6) Never. The scores were reversed coded so that a higher score indicated more private religious activities. Due to low number of participants in the lower range of scores, NORA was recoded into two categories: once or less than once per week and more than once per week.

3.4.3.3. Intrinsic religiosity

Intrinsic religiosity is characterized as religion that is an end in itself; intrinsically motivated individuals *live* their religion, as compared to extrinsically motivated individuals who *use* their religion as a means to an end, for example, to seek social networks, status, security and comforts etc. (Allport & Ross, 1967; Masters, 2013). Many of the studies on intrinsic religiosity have been done in mental health. Previous studies have shown that a higher level of intrinsic religiosity is associated with better psychological well-being (Donahue, 1985), quicker remission among depressed patients (Koenig, George, & Peterson, 1998), and less depressive symptoms among older patients (Koenig et al., 2004). However, whether the relationship between intrinsic religiosity and positive mental health outcomes is causal remains an open question.

The participants were given three statements about their religious beliefs or experience and indicate the extent to which each statement is true to him or her. An example of statement includes *In my life, I experience the present of God*. The participants scored from 1 (*Definitely true of me*) to 6 (*Definitely not true of me*). The scores were reversed coded so that a higher score indicated higher intrinsic

religiosity. The Cronbach's alpha for the intrinsic religiosity subscale in this study was 0.60.

3.4.3.4. Sabbath-keeping

The Adventist Church believes that the Sabbath is a Holy day of rest that begins on Friday sunset and ends at Saturday sunset. The Church encourages its members to keep the Sabbath by attending worship services and not engaging in secular activities.

The Secular Activities on Sabbath is one of subscales of the five-factor (Sabbath gives rest, extrinsic social Sabbath-keeping, keeping Sabbath because of guilt/shame, Sabbath helps connect to God, and Secular Activities on Sabbath) Sabbath Belief and Activity Scale (Lee et al., 2006, April). The Sabbath-Keeping Scale was developed from the 51-item preliminary measure of Sabbath beliefs, which was administered to 408 participants from the Adventist Health Study-2 cohort of 97,000 persons to study the relationship between Sabbath-keeping and other religious measures and physical and mental health (Lee et al., 2006, April). The Secular Activities on Sabbath subscale has been used in Adventist Health Study-2 to examine the mediators in the relationship between Sabbath-keeping and physical and mental health and has a Cronbach's α of 0.65 (Superville et al., 2014).

The Secular Activities on Sabbath subscale measures how much a participant engages in secular activities such as shopping, reading secular magazines,

attending secular concert or watching movie, and watching or listening to news programmes during Sabbath. It is scored on a 6-point response scale from 1 (*every Sabbath*) to 6 (*never*). The scores were reversed coded so that a higher score indicated better Sabbath-keeping. The internal consistency of the scale in this study is acceptable (Cronbach's $\alpha = 0.80$).

3.4.4. Lifestyle Variables

3.4.4.1. Alcohol Consumption

Alcohol consumption was measured by the Alcohol Consumption subscale of WHO STEPS Instrument. The eight-item subscale assessed alcohol consumption in the past 12 months and 30 days (World Health Organization, 2013b). Some examples of questions: *Have you ever consumed an alcoholic drink in the past 12 months? During the past 12 months, how frequently have you had at least one alcoholic drink?*

3.4.4.2. Exercise

Exercise was measured by the Godin Leisure-Time Exercise Questionnaire (GLTEQ), a brief four-item scale that assessed average physical activity in a week by summing up the products of strenuous, moderate and light activities with their respective constants (Godin & Shephard, 1997). GLTEQ has been used to measure physical activity in various samples, such as overweight adults (Sarkin et al., 2001) and adolescents (Neumark - Sztainer et al., 2009), diabetic patients (Tan & Magarey, 2008), dog owners (Brown & Rhodes, 2006), depressed patients (Hoffman et al., 2011) and so forth. In a psychometric study of the scale that included 306 healthy adults, the items successfully discriminated between fit and

unfit participants and between participants with low and high body fat percentage (Godin & Shephard, 1985). The two-week test-retest reliability of the discriminant functions classifying fit/unfit and thin/fat participants was satisfactory (reliability coefficients = 0.83 and 0.85) (Godin & Shephard, 1985).

3.4.4.3. Smoking

The participants were asked about their past and current smoking habits (Anderson et al., 1978; Hixson & Morgan, 1998). Some examples of the questions include *Have you ever smoked cigarettes during any period of your life? What is the greatest number of cigarettes that you have ever regularly smoked?*

3.4.5. Self-Reported Anthropometric Measurements and History of Diseases

The self-reported anthropometric measurements included height, weight, and waist and hip circumferences. BMI and waist-to-hip ratio were computed. The self-reported history of diseases included history of hypertension and diabetes.

3.4.6. Demographic Variables

For demographics, the participants were asked about their age, gender, ethnicity, marital status, employment status, monthly household income, level of education, age of conversion/baptism, and whether they are born into an Adventist family. There were four categories of ethnicity: Chinese, Indians, non-Malay and non-Muslim Bumiputras (natives of Sabah and Sarawak states of Malaysia) and Others. Employment status was examined using five categories: employed, unemployed, retired, homemaker and student. For statistical analysis, the last four categories (unemployed, retired, homemaker and student) were into the category

'unemployed'. Monthly household income of the participants was categorized as less than RM1000 (USD257), RM1001-2999 (USD257-771), RM3000-4999 (USD771-1285), and RM5000 (USD1285) and above. The highest education level of participants was categorized as secondary school or less, diploma (a higher education qualification just below a bachelor's degree), and bachelor's degree or above.

3.4.7. Health Screening Measurements

Community health screenings were conducted to measure blood pressure, random blood glucose level, weight, height, and waist and hip circumferences in a sub-group of participants.

3.4.7.1. Blood Pressure

Systolic and diastolic blood pressures were measured using Omron HEM-7203 automatic blood pressure monitor. The participants were seated and rested for 10 minutes before their blood pressure was measured by volunteer second-year medical students who had had no previous clinical practice; and three readings of blood pressure were taken at a five minutes interval and the results were averaged (Iyriboz & Hearon, 1992).

It is expensive to hire health workers to conduct health screening, thus, it a common practice to include non-health workers. One of the concerns in the use of non-health workers (such as medical students) in community health screening is whether the measurements obtained through electronic blood pressure monitor by non-health workers are as accurate as those obtained through mercury

sphygmomanometers by health workers. There is evidence that blood pressure measured by non-health workers using electronic blood pressure monitor is not significantly different from that measured by qualified health workers (Reidpath et al., 2012).

3.4.7.2. Random Blood Glucose Level

Random blood glucose level was measured using Omron HEA0221 blood glucose meter. A drop of blood was obtained by pricking the participants' ring fingers and placed on the disposable test strip, which was read by the glucose meter.

Similar to the electronic blood pressure monitor, the accuracy of glucose meter is also a common concern. The results from glucose meter is not as accurate as those from laboratory results and many factors could affect the accuracy of glucose meter, such as failure to calibrate the glucose meter regularly, poor hand washing, dirty meters, improper storage of test strips and so on (Saudek et al., 2006). The error grid analysis, which evaluates the accuracy of glucose meter by comparing the results obtained from glucose meter with a reference value, breaks down a scatterplot into five zones that represents level of accuracy (Clarke et al., 1987). Zones A represents glucose values that deviate from the reference by no more than 20% and Zone B represents values that deviate from the reference by more than 20% but would not lead to inappropriate treatment, while Zone C to E indicate inaccurate readings that could lead to inappropriate treatment (Clarke et al., 1987). Many clinical studies of the accuracy of glucose meter have shown that

glucose meter provide results that are in Zones A and B (Arabadjief & Nichols, 2006).

3.4.7.3. Weight and Height

Body mass index (BMI), a widely used measure of body size, is a ratio of weight and height. It is calculated by dividing weight in kilograms with the square of height in metre (kg/m^2); an BMI of $25 \text{ kg}/\text{m}^2$ and above is considered overweight and an BMI of $30 \text{ kg}/\text{m}^2$ and above is considered obese (World Health Organization, 2000). A higher BMI has been shown to be associated with higher risks of cardiovascular diseases (Tirosh et al., 2011) and type-II diabetes (Narayan et al., 2007). However, these BMI cut-off points for overweight and obesity are based on Caucasian/European populations. Asian populations have a higher body fat percentage at similar BMI and studies have shown that mortality and morbidities among Asians occur at a lower BMI (Reddy et al., 2002; Yoshiike et al., 2002; Zhou, 2002). The suggested cut-off points for overweight and obesity among Asians are $23 \text{ kg}/\text{m}^2$ and $27.5 \text{ kg}/\text{m}^2$, respectively (Ismail et al., 2004). Since almost all the participants of the current study are Asians, these lower cut-off points were used.

In this study, weight and height were measured using Deluxe GBS-721 scale with height gauge. The participants removed their shoes and cleared their pockets before the measurements. BMI was calculated automatically by the scale.

3.4.7.4. Waist and Hip Circumferences

BMI is a simple ratio between body weight and height and tends to overestimate degree of obesity in very muscular individuals, underestimate individual who

have lost muscles mass, and be exaggerated in very short or tall people and in the presence of oedema (Ismail et al., 2004).

Abdominal obesity has been shown to be associated with increased risk of cardiovascular diseases (Mahabadi et al., 2009). However, BMI does not account for individual body fat distribution. Studies have shown that there is a wide range of body fat distribution even between people with similar BMIs (World Health Organization, 2000). Abdominal obesity could be measured by waist circumference, waist-hip ratio and the less common waist-height ratio (Huxley et al., 2010). In fact, waist circumference and waist-hip ratio have been shown to be a better indicator of risk of cardiovascular diseases (De Koning et al., 2007; Savva et al., 2000; Welborn et al., 2003), diabetes (Qiao & Nyamdorj, 2010) and all-cause mortality (Seidell, 2010). However, other studies have shown that BMI and waist-hip-ratio are no different than BMI in predicting cardiovascular diseases (Dalton et al., 2003) and diabetes (Vazquez et al., 2007).

Similar to BMI, the cut-off points of waist circumference and waist-hip ratio associated with increased risks are specific to ethnic groups. In a study of Singaporean Chinese, Malays and Indians, it was found these ethnic groups have higher body fat percentage compared with Caucasians at a given BMI (Deurenberg et al., 2002; Deurenberg-Yap, 2000). The World Health Organization suggested that the waist circumferences greater than 94cm for men and 80cm for women and a waist-hip ratio greater than 1.0 in men and .85 in women are associated with increased risks of diseases (World Health Organization, 2000). However, evidence from various studies that included Asians recommend that while waist-hip ratio

should remain the same as the Caucasians, a lower cut-off points for waist circumferences should be use (Ismail et al., 2004). For comparison with the waist circumference of the Malaysian population, a cut-off points greater than 90cm for men and greater than 80cm for women were used in this study (Institute for Public Health, 2015).

In this study, waist and hip circumferences were measured using a flexible measuring tape. The participants were standing upright during the measurement. Waist circumference was measured at the midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the mid-axillar line and hip circumference was measured at the largest circumference of the buttocks (World Health Organization, 2008). Waist-to-hip ratio was computed for males and females.

3.5. Translation of Questionnaires

Validated translated questionnaires were used where available. Validated Malay translations were available for DUREL (Nurasikin et al., 2010) and validated Chinese translation was available for HPLP-II Nutrition Subscale (Teng et al., 2010).

When validated translations were unavailable, the questionnaires were translated into Chinese and Malay by native speakers. The official Chinese translation of DUREL, and WHO STEPS Instruments for diet, alcohol consumption, history of diabetes and history of raised blood pressure were unsatisfactory and they were

retranslated. All questionnaires were back-translated into English by native Chinese and Malay speakers who were also fluent in English.

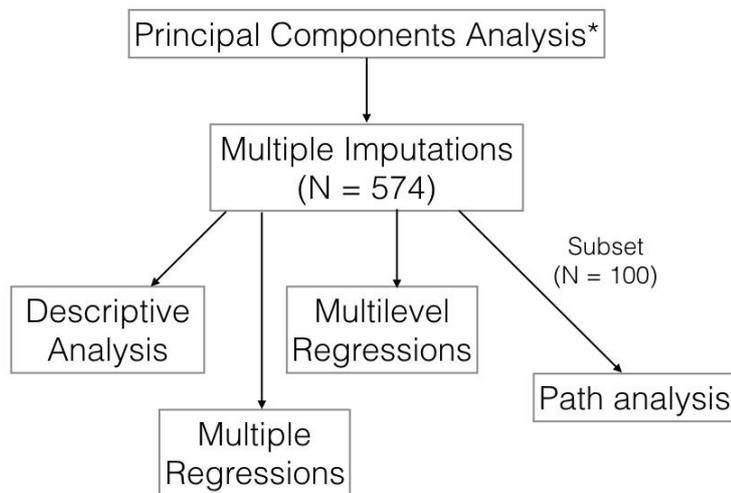
3.6. Pilot Testing of Questionnaires

The questionnaires were pilot tested for readability. Three elders were asked to fill in the questionnaire for pastors/elders and nine Adventists (three for each language) from PMM who were not pastors/elders were asked to fill in the questionnaire for congregational members. The questionnaires were edited based on the comments from the pilot testing participants.

3.7. Analyses

The data were analysed in the following sequence. First principal component analysis (PCA) was conducted on the religious variables. Then multiple imputations were conducted on all the variables (including dependent variables) (Young & Johnson, 2010). Five imputed datasets ($N=574$) were obtained and they were used subsequently in descriptive analysis, multiple regressions, and multilevel regressions. A subset of each of the dataset ($N=100$) were used in path analysis. Figure 2 is the flowchart of data analysis of this study:

Figure 2. Main steps in data analysis.



*Only conducted on religious variables

Data were analysed with R statistical software (R Core Team, 2015).

3.7.1. Principal Components Analysis

Principal components analysis (PCA) is a multivariate statistical technique that analyses a set of inter-correlated variables of a dataset and convert them into linearly uncorrelated variables called principal components (Abdi & Williams, 2010). It could be conducted before performing regression to explore the relationship between variables. More importantly, it is used to overcome multicollinearity problems in regression (Sainani, 2014; Tabachnick & Fidell, 2013).

In this study, PCA was conducted on the religious variables to determine whether the items cluster together within their scales, using the *psych* package in R (Revelle, 2015). The four religious scales included in PCA were Religious Attendance (one item), Private Religious Activities (one item), Intrinsic Religiosity (three items), and Secular Activities on Sabbath (six items). The Secular Activities

on Sabbath items and Intrinsic Religiosity items clustered among themselves closely, indicating that they are two distinctive scales. Religious Attendance and Private Religious Activities, both single-item, clustered with each other. However, in this study, these two subscales were kept separated rather being summed into one scale based on the recommendation of their authors (Koenig & Bussing, 2010). The details of the PCA are found in [Appendix K](#).

3.7.2. Multiple Imputation of Missing Data

In this study, the original dataset contained 607 cases. Thirty-three cases (5.4%) from participants who were below 18 years old, Adventists not residing in West Malaysia or non-Adventists, and who did not specify their age, were removed before multiple imputation. Table 3 shows the number and percentage of missing values of the current study after the removal of the thirty-three cases.

Table 3. Missing data in the dataset after removal of cases that do not fit into the selection criteria.

Variables	Number of missing values (out of 574)	% of missing values
Religious variables		
Religious attendance	11	1.9
Private religious activities	11	1.9
Intrinsic religiosity	15	2.6
Sabbath keeping	31	5.4
Dietary variables		
Dietary habits	22	3.8
Fruit and vegetable intake	59	10.4
Vegetarian status	16	2.8
Demographic variables		
Gender	0	0

Ethnicity	2	0.4
Marital status	8	1.4
Monthly household income	70	12.2
Occupation	9	1.6
Education	12	2.1
Age of baptism	55	9.6
Born in Adventist family	10	1.7

Overall the percentage of missing data was small, except monthly household income (12.2%), fruit and vegetable intake (10.3%), and age of baptism (9.6%). Of the 70 cases with missing data on monthly household income, 26 (37.1%) were students, and this might be the main reason of its high percentage of missingness compared with other variables because the students might not be sure about their monthly household income. The fruit and vegetable intake item asked the participants how many average servings of fruit/vegetable they consume per day. One possible reason for the high proportion of missingness for fruit and vegetable intake could be that the participants might not know how to calculate average serving, even though references to serving size had been included in the questionnaire. Whether one was born in Adventist family also has high missingness compared with other variables maybe because the participants were not sure about the exact definition of “born in Adventist family”; there were cases where participants were born in families where only one of the parents was Adventist.

Missing data is a common problem in public health research. Rubin (1976) proposed three mechanisms of missing data: missing completely at random

(MCAR), missing at random (MAR) and missing not at random (MNAR). MCAR means the missingness of variable X is unrelated to other variables in the data and also to the underlying values of X itself; MAR is less restrictive than MCAR in that missingness could be related to other variables but still must be unrelated to the values of X; and MNAR means that missingness is related to the underlying values of X.

The most common methods of handling missing data is listwise and pairwise deletion (Peugh & Enders, 2004). Listwise deletion removes all cases that have missing values, while pairwise deletion removed cases with missing data depending on the variables that are used in statistical analysis. Even though listwise and pairwise deletion are convenient to implement, they are considered the worst methods to handle missing data and strongly discouraged (Wilkinson, 1999). Both deletion methods requires MCAR data and could produce distorted results when this assumption is violated (Enders, 2010).

Modern missing data handling techniques, such as multiple imputation, are recommended over the traditional methods (Peugh & Enders, 2004). Multiple imputation, developed in the late 1980s, is a statistical technique to impute incomplete data and has been shown to reduce bias and increase efficiency compared to listwise deletion (Honaker et al., 2011). Unlike other procedures for handling missing data, multiple imputation does not assume that the data MCAR (Enders, 2010; Tabachnick & Fidell, 2013). Multiple imputation is gaining popularity (Rubin, 1996) and has been used in various studies such as adult

attention deficit/hyperactivity disorder (Kessler et al., 2006), cost-effectiveness of chemotherapy (Burton et al., 2007), census (Clogg et al., 1991) etc.

Multiple imputations create multiple copies (usually 3-5) of the original dataset and the missing values are replaced by the imputed values (Peugh & Enders, 2004; Rubin, 2004; Sterne et al., 2009). In this study multiple imputations were conducted using the *Amelia* package in R (Honaker et al., 2011). All the variables that were used in subsequent analysis were multiply imputed, including the dependent variables (Young & Johnson, 2010). Five imputations were obtained for each multiple imputation. Multiple imputation is highly efficient in that a small number of copies could produce is sufficient to produce excellent results; for example, for a dataset with 30% missing data, five imputations produces 94% efficiency, while ten imputations produces 97% efficiency (Schafer & Olsen, 1998). Statistical analysis was then conducted on each of the imputed dataset and the results are pooled according to Rubin's rule (Rubin, 2004). Pooled parameter estimates are calculated by taking the arithmetic mean of the estimates from each data set while pooled standard error are calculated using within-imputation and between-imputation variance (Baraldi & Enders, 2010). The within-imputation variance is the arithmetic average of the squared standard errors, calculated as follows:

$$W = \frac{\sum SE_t^2}{m},$$

where W is the within-imputation variance, SE is standard error, t denotes a particular imputed data set, m the total number of imputed data sets. The between-imputation variance is calculated using the following formula:

$$B = \frac{\sum(\hat{\theta}_t - \bar{\theta})^2}{m-1},$$

where B is the between-imputation variance, $\hat{\theta}_t$ is the parameter estimate from data set t , and $\bar{\theta}$ is the average parameter estimate, and m the total number of imputed data sets.

The pooled standard error includes both within- and between-imputation variance:

$$SE = \sqrt{W + B + \frac{B}{m}},$$

where SE is the pooled standard error, W is the within-imputation variance, B is the between-imputation variance and m is the total number of imputed data sets.

Multiple imputation, like other statistical techniques, is based on certain assumptions. In order to produce unbiased estimates, multiple imputation requires that the data are MAR (Peugh & Enders, 2004). If data are MNAR multiple imputation might produce misleading results. One way to make the MAR assumption more plausible is to include a variety of variables in multiple imputation even if they might not be used in subsequent statistical analysis (Sterne et al., 2009). In this study, all variables, except congregational conservativeness, were included in multiple imputations.

Multiple imputation also assumes that data are normally distributed (Sterne et al., 2009). Non-normal data should be transformed before multiple imputation and the imputed values are transformed back to the original scale. However, there is evidence showing that the violation of normality does not affect parameter estimates seriously (Graham & Schafer, 1999). In this study, nominal data were specified in the *Amelia* package, which transformed them before multiple imputations and all the imputations that were created were returned to the original untransformed form (Honaker et al., 2011).

3.7.3. Descriptive Analysis

Mean and standard deviations were computed for continuous data and percentages were computed for categorical data. T-test (for continuous data) and chi-square (for categorical data) were conducted to determine whether there were gender differences between the variables.

3.7.4. Individual Religiosity and Diet

Multiple linear and logistic regressions were conducted using the *stats* package in R (R Core Team, 2015). The subscales of the Duke University Religion Index (DUREL) were analysed independently in separate regression models rather than being summed into a total religiosity score. This approach follows the advice of the DUREL scale developers (Koenig, 2011; Koenig & Bussing, 2010). If all subscales are included in one regression model, the effects of religious attendance and private religious activities might cancel out each other since diet may be positively associated with religious attendance and negatively associated with private religious activities. Separating the religious variables also avoids issues of multi-

collinearity among the independent variables, and allows the estimation of each possible effect.

3.7.4.1. Multiple Linear Regressions

In this study, multistep multiple linear regression analysis was conducted to analyse the relationship between individual religiosity and diet. The religious variables included for this analysis were religious attendance, private religious activities, intrinsic religiosity and Sabbath keeping and the dietary variables were dietary habits and fruit and vegetable intake, both of which were continuous. Each religious variable was examined in separate regression models to avoid problems of multi-collinearity (Koenig, 2011), see section 3.4.3. First the religious variables were entered into the model to obtain the parameter coefficients for the bivariate relationship between the religious variables and dietary variables. In this section, only models including religious attendance are provided. Models including other religious variables are found in [Appendix L.1](#). The bivariate model for dietary habits and religious attendance is specified below:

$$DH = \beta_0 + \beta_1(\text{Religious attendance}) + \varepsilon$$

where DH denotes dietary habit, β_0 is the intercept, β_1 is regression coefficient, and ε is the error term.

The bivariate model for fruit and vegetable intake and religious attendance is specified below:

$$FV = \beta_0 + \beta_1(\text{Religious attendance}) + \varepsilon$$

where FV denotes fruit and vegetable intake, β_0 is the intercept, β_1 is regression coefficient and ϵ is the error term.

In the next step the covariates (age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether they are born into an Adventist family) were entered to determine whether there was a significant relationship between the religious variables and the dietary variables.

The model for dietary habits and religious attendance is specified below:

$$\begin{aligned} \text{DH} = & \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Ethnicity}) + \beta_4(\text{Marital Status}) + \\ & \beta_5(\text{Employment}) + \beta_6(\text{Income}) + \beta_7(\text{Education}) + \beta_8(\text{Age of Baptism}) + \\ & \beta_9(\text{Born in Adventist} \end{aligned}$$

where DH denotes dietary habit, β_0 is the intercept, β_1 - β_{10} are regression coefficient, and ϵ is the error term.

The model for fruit and vegetable intake and religious attendance is specified below:

$$\begin{aligned} \text{FV} = & \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Ethnicity}) + \beta_4(\text{Marital Status}) + \\ & \beta_5(\text{Employment}) + \beta_6(\text{Income}) + \beta_7(\text{Education}) + \beta_8(\text{Age of Baptism}) + \\ & \beta_9(\text{Born in Adventist Family}) + \beta_{10}(\text{Religious Attendance}) + \epsilon \end{aligned}$$

where FV denotes fruit and vegetable intake, β_0 is the intercept, β_1 - β_{10} are regression coefficients, and ϵ is the error term.

3.7.4.2. Multiple Logistic Regressions

One of the assumptions of multiple linear regression is a linear relationship between independent and dependent variables (Field et al., 2012). When the dependent variable is dichotomous, this assumption is violated (Berry, 1993) and logistic regression is more appropriate. Dichotomous outcomes are assumed to follow a binomial distribution and a logistic regression equation expresses multiple linear regression in logarithmic term (logit) in order to overcome non-linearity of data (Kleinbaum & Klein, 2010). In logistic regression, the probability of dependent variable is predicted. The general model of logistic regression is as the following:

$$P(X) = \frac{1}{1 + e^{-(\beta_0 + \sum \beta_i X_i)}}$$

where $P(X)$ is the probability of X , e is the base of natural logarithms, β_0 is the intercept and β_1 the regression coefficient from linear regression.

In this study, multistep multiple logistic regression analysis was conducted to analyse the relationship between individual religiosity and vegetarian status, a dichotomous variable. The religious variables included for this analysis were religious attendance, private religious activities, intrinsic religiosity and Sabbath-keeping. Similar to multiple linear regressions in the previous subsection, each religious variable was examined in separate regression models. First the religious variables were entered into the model to obtain the parameter coefficients for the bivariate relationship between the religious variables and vegetarian status. In this section, only models including religious attendance are provided. Models

including other religious variables are found in [Appendix L.2](#). The bivariate model for fruit and vegetable intake and religious attendance is specified below:

$$P(\textit{Vegetarian}) = \frac{1}{1 + e^{-(\beta_0 + \beta_1(\textit{Religious Attendance}))}}$$

where $P(\textit{Vegetarian})$ denotes the probability of being vegetarian, β_0 is the intercept, and β_1 is regression coefficient.

Then the covariates (age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether they are born into an Adventist family) were entered to determine whether there was a significant relationship between the religious variables and vegetarian status. The model are specified below:

$$P(\textit{Vegetarian}) = \frac{1}{1 + e^{-(\beta_0 + \beta_1(A) + \beta_2(G) + \beta_3(E) + \beta_4(\textit{MS}) + \beta_5(\textit{In}) + \beta_6(\textit{Edu}) + \beta_7(\textit{AB}) + \beta_8(\textit{AF}) + \beta_{10}(\textit{RA}))}}$$

where $P(\textit{Vegetarian})$ denotes the probability of being vegetarian, β_0 is the intercept, and β_1 - β_{10} are regression coefficients, A=age, G=gender, E=ethnicity, MS=marital status, In=income, Edu=education, AB=age of baptism, AF=born in Adventist family, RA=religious attendance.

Odds ratios were calculated by exponentiating the regression coefficients. To determine the 95% confidence intervals for the odds ratios, bootstrapping was conducted 1,000 times on each of the five imputed datasets. The means of coefficients were obtained from the five sets of bootstrap samples and sorted in ascending order. The 25th and 975th values were exponentiated to obtain the 95%

confidence interval. Bootstrapping was employed because it does not assume normality of the sampling distribution (Efron & Tibshirani, 1994; Mooney & Duval, 1993).

3.7.5. Social Gradient and Diet

3.6.5.1. Multiple Linear Regressions

Multistep hierarchical multiple regression analysis was conducted to analyze the relationship between socioeconomic variables and dietary habits. First, each socioeconomic variable (education, employment, income) was entered separately into the model to obtain the parameter coefficients for the bivariate relationship between the socioeconomic variable and dietary variable. The models are specified below:

$$DH = \beta_0 + \beta_1(\text{Education}) + \varepsilon$$

$$DH = \beta_0 + \beta_1(\text{Employment}) + \varepsilon$$

$$DH = \beta_0 + \beta_1(\text{Income}) + \varepsilon$$

where DH denotes dietary habit, β_0 is the intercept, β_1 's are regression coefficients, and ε is the error term.

Then, the socioeconomic variables were entered one at a time together with demographic variables (age, gender, ethnicity, marital status, age of conversion/baptism, and whether the participants were born into an Adventist family), and religious attendance. The models are specified below:

$$DH = \beta_0 + \beta_1(\text{Education}) + \beta_2(\text{Age}) + \beta_3(\text{Gender}) + \beta_4(\text{Ethnicity}) + \beta_5(\text{Marital Status}) + \beta_6(\text{Age of Baptism}) + \beta_7(\text{Born in Adventist Family}) + \beta_8(\text{Religious Attendance})$$

$$DH = \beta_0 + \beta_1(\text{Employment}) + \beta_2(\text{Age}) + \beta_3(\text{Gender}) + \beta_4(\text{Ethnicity}) + \beta_5(\text{Marital Status}) + \beta_6(\text{Age of Baptism}) + \beta_7(\text{Born in Adventist Family}) + \beta_8(\text{Religious Attendance})$$

$$DH = \beta_0 + \beta_1(\text{Income}) + \beta_2(\text{Age}) + \beta_3(\text{Gender}) + \beta_4(\text{Ethnicity}) + \beta_5(\text{Marital Status}) + \beta_6(\text{Age of Baptism}) + \beta_7(\text{Born in Adventist Family}) + \beta_8(\text{Religious Attendance})$$

where DH denotes dietary habit, β_0 is the intercept, β_1 - β_8 are regression coefficient, and ε is the error term.

In the last step, all three socioeconomic variables, demographic variables and religious attendance were entered together.

$$DH = \beta_0 + \beta_1(\text{Education}) + \beta_2(\text{Employment}) + \beta_3(\text{Income}) + \beta_4(\text{Age}) + \beta_5(\text{Gender}) + \beta_6(\text{Ethnicity}) + \beta_7(\text{Marital Status}) + \beta_8(\text{Age of Baptism}) + \beta_9(\text{Born in Adventist Family}) + \beta_{10}(\text{Religious Attendance})$$

where DH denotes dietary habit, β_0 is the intercept, β_1 - β_{10} are regression coefficient, and ε is the error term.

3.7.6. Congregational Effect and Diet: Multilevel Analysis

3.7.6.1. Multilevel Linear Regressions

Data generally are hierarchical or clustered in nature (Braveman et al., 2010), for example, schoolchildren are nested within classrooms, employees are nested

within companies, congregants are nested within congregations. The characteristics of the cluster/group where a person belongs to might influence individual characteristics; for example, schoolchildren are nested within classrooms with different characteristics such as the types of teachers, and the classrooms are clustered within schools, which are located in areas with different socioeconomic status.

One older approach to analyse hierarchical data is to disaggregate group-level variable to the individual-level and examine individual- and group-level variables both at the individual level (Hox, 1998). However, this approach can lead to the atomistic fallacy, where inferences regarding variability across groups are drawn based on individual data (Diez, 2002). For example, a study might find that increased individual income is associated with decreased mortality from coronary heart disease. Atomistic fallacy is committed when one infers from the individual data that increased per capita income at the country level is also associated with decreased mortality from coronary heart disease. Since individual who belong to the same group tend to be more similar than those from other groups, this approach also violates the assumption of independence of observations in single-level ordinary-least squares (OLS) regression (Luke, 2004). Another traditional approach to analyse hierarchical data is to aggregate individual level variables to group-level and conduct statistical analysis at group level (Hox, 1998). This can lead to the ecological fallacy, where inferences at the individual level are drawn based on group-level data (Diez, 2002). An example of ecological fallacy is to infer that women who consume a lot of fat are more likely to get breast cancer because

epidemiological studies have shown that countries that have high fat consumption also have high breast cancer mortality rate. The problems with these two approaches to multilevel data lead to an increased interest in statistical methods suitable for multilevel analysis. Multilevel modelling is an extension of ordinary least squares regression so that multiple level data can be analysed (Paterson & Goldstein, 1991).

In multilevel modelling, there are: 1) the unconstrained or null model, which contains no level 1 or level 2 predictors and is used to determine whether there was significant congregational-level variance to warrant the use of multilevel modelling; 2) the random intercept model where level 1 intercepts vary across level 2 units but level 1 slopes are held constant; and 3) the model where both intercepts and slopes vary across level 2 units (Gelman & Hill, 2006; Luke, 2004). Random-slope and random-intercept model is recommended when one wants to study the cross level interaction between individual and group level variables (Luke, 2004). The purpose of the current study was to examine congregational effect on diet and cross level interaction was not included. Thus, only null and random-intercept models were included in this study.

The general model of a two-level random-intercept multilevel model with one predictor at the individual level and one predictor at the group level is as the following:

$$\text{Level 1: } Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + r_{ij}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + \gamma_{01}W_j + u_{0j}$$

where Y_{ij} is the score on the dependent variable for i^{th} individual in j^{th} group, X_{ij} is the individual-level predictor for i^{th} individual in j^{th} group, β_{0j} is the intercept of the dependent variable in group j , β_{1j} is slope for the relationship in group j between individual-level predictor and the dependent variable, r_{ij} is the individual-level errors, γ_{00} is the grand mean value of the score of the individual-level dependent variable when all the predictors are equal to 0, W_j is the group-level predictor, γ_{01} is the slope between the dependent variable and the group-level predictor, u_{0j} is the error for the intercept.

The combined formula is specified below:

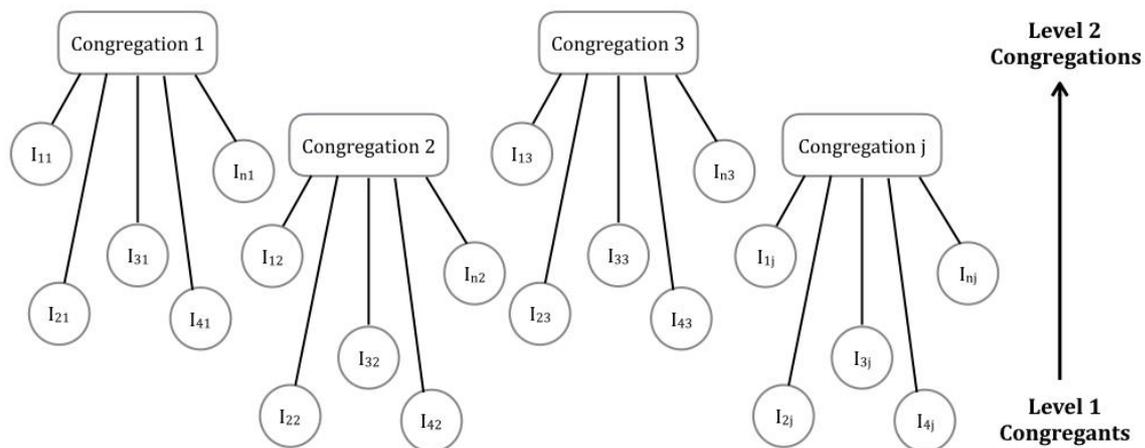
$$Y_{ij} = \underbrace{[\gamma_{00} + \gamma_{10}X_{ij} + \gamma_{01}W_j + \gamma_{11}W_jX_{ij}]}_{\text{fixed}} + \underbrace{[u_{0j} + u_{1j}X_{ij} + r_{ij}]}_{\text{random}}$$

When a linear model contains both fixed-effects and random-effects terms, it is also known as mixed models. The fixed part is held constant across groups while the random part is allowed to vary across groups (Diez, 2002).

In a multilevel analysis, two variances were examined: the group-level variance, which “reflects the degree to which groups differ in their mean values (intercepts) on the dependent variable”, and the individual-level variance, which “reflect the degree to which an individual score differs from its predicted value within a specific group “ (Kavanagh et al., 2010).

In this study, multilevel modelling was used to examine how individual religiosity and congregational conservativeness was associated with individual diet while controlling for individual demographics. The current study used two-level data, where the congregants are clustered within congregations, as shown in Figure 3. The data were analysed with *nlme* package in R software (Pinheiro et al., 2016).

Figure 3. A two-level hierarchical structure.



Multilevel Linear Regression Model Building

Model o (null model). A baseline/null model was constructed for each of the two continuous dietary variables (dietary habits and fruit and vegetable intake). A null model does not include predictors but random intercept variance term for groups (congregations). The purpose of examining a null model was to determine whether there was significant congregational-level variance to warrant the use of multilevel modelling. The model is specified as follow:

$$\text{Diet}_{ij} = \beta_{0j} + r_{ij}$$

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

The combined form: $\text{Diet}_{ij} = \gamma_{00} + u_{0j} + r_{ij}$

Diet_{ij} denotes the dietary variable for individual *i* nested in the congregation *j*, γ_{00} is the mean score of dietary variable in congregation *j*, u_{0j} is congregational-level error and r_{ij} is individual-level error.

To determine how much of the variance in dietary habits can be explained by congregational level, the intra-class correlation (ICC) was computed from the variance components by using the following formula (Luke, 2004):

$$ICC = \frac{\sigma_{u_0}^2}{(\sigma_{u_0}^2 + \sigma_r^2)}$$

Where $\sigma_{u_0}^2$ is the congregational-level variance, and σ_r^2 is the individual-level variance. To test whether $\sigma_{u_0}^2$ was significantly larger than zero, the -2 log likelihood value of the null model, which had a random intercept, was compared to that of the model without a random intercept (Kavanagh et al., 2010). $\sigma_{u_0}^2$ is significant if the -2 log likelihood of the null model is larger. A significant $\sigma_{u_0}^2$ indicates the need for multilevel modelling.

For dietary habits, there was a significant congregational clustering. However, for fruit and vegetable intake, there was no significant intercept variation, thus no significant congregational clustering. Multilevel modelling was unnecessary for fruit and vegetable intake.

Model 1. In this model the relationship between dietary habits and demographics (age, gender, ethnicity, marital status, employment status, income, level of

education, age of conversion/baptism, and whether they are born into an Adventist family) were examined. The model is specific as below:

$$DH_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + u_{0j} + r_{ij}$$

DH_{ij} denotes dietary habits for individual i nested in the congregation j , γ_{00} is the intercept, β_{1-9} are the coefficients, u_{0j} is congregational-level error and r_{ij} is individual-level error.

Models 2. Models 2 built on model 1 and added individual religious variables. In this section, only models including religious attendance are provided. Models including other religious variables are found in [Appendix M.1](#) . The model is specified as below:

$$DH_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Religious Attendance})_{ij} + u_{0j} + r_{ij}$$

DH_{ij} denotes dietary habits for individual i nested in the congregation j , γ_{00} is the intercept, β_{1-10} are the coefficients, u_{0j} is congregational-level error and r_{ij} is individual-level error.

Models 3. Models 3 built on model 2 and included congregational size and conservativeness. The model is specified below:

$$DH_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} +$$

$$\beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Religious Attendance})_{ij} + \beta_{11}(\text{Congregational Conservativeness})_{ij} + u_{0j} + r_{ij}$$

DH_{ij} denotes dietary habits for individual *i* nested in the congregation *j*, γ_{00} is the intercept, β_{1-11} are the coefficients, u_{0j} is congregational-level error and r_{ij} is individual-level error.

Coefficient of Determination (r^2)

Explained variance is an important concept in multiple regression, and the usual measure for the proportion of variance modelled by the explanatory variables is the coefficient of determination, R^2 (Bliese, 2006). For multilevel model, the concept of explained variance is problematic because there is more than one level in the analysis. Since there are multiple levels, there are also multiple R^2 and R^2 is calculated at each level. For the R^2 explained at the individual level, the following formula was used (Bliese, 2006):

$$R_1^2 = \frac{\sigma_{eb}^2 - \sigma_{em}^2}{\sigma_{eb}^2}$$

where R_1^2 is the proportion of variance explained at the individual level, σ_{eb}^2 is the individual level variance of the baseline model, which is the null model, and σ_{em}^2 is the individual level variance for the comparison model.

For R^2 explained at the congregational level, the following formula was used:

$$R_2^2 = \frac{\sigma_{ub}^2 - \sigma_{um}^2}{\sigma_{ub}^2}$$

where R_2^2 is the proportion of variance explained at the congregational level, σ_{eubb}^2 is the congregational level variance of the baseline model, which is the null model, and σ_{um}^2 is the congregational level variance for the comparison model.

Model Fit

Akaike Information Criterion (AIC), and $-2 \log$ likelihood of the fitted models were compared. A better fit was indicated by reduced AIC and $-2 \log$ likelihood. Chi-square tests were conducted to compare deviances of different models.

3.7.6.2. Multilevel Logistic Regression

When the dependent variable is categorical, it is necessary to use a generalized multilevel model rather than a linear multilevel model due to violation of the assumption of normality (Bolker et al., 2009). As in logistic regression, multilevel logistic regression also utilizes the logit transformation. The general model of a two-level generalized multilevel model with one predictor is as the following:

$$\text{Level 1: } \eta_{ij} = \beta_{0j} + \beta_{1j}X_{ij}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + \gamma_{01}W_j + u_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

where η_{ij} is the log odds of the score of the dependent variable for i^{th} individual in j^{th} group, X_{ij} is the individual-level predictor for i^{th} individual in j^{th} group, β_{0j} is the intercept of the dependent variable in group j , β_{1j} is slope for the relationship in group j between individual-level predictor and the dependent variable. There is no term for level 1 error variance since the variance is a directly determined by the mean (Luke, 2004).

In level 2, γ_{00} is the log odds of the score of the individual-level dependent variable, W_j is the group-level predictor, γ_{01} is the slope between the dependent variable and the group-level predictor, u_{0j} is the error for the intercept, γ_{10} is the slope between the dependent variable and the individual-level predictor, and u_{1j} is the error for the slope.

The combined formula is specified below:

$$\eta_{ij} = \gamma_{00} + \gamma_{10}X_{ij} + \gamma_{01}W_j + u_{0j}$$

In this study, multilevel logistic regression was conducted to examine how individual religiosity and congregational characteristics were associated with individual vegetarian status while controlling for individual demographics. The data were analysed with *lme4* package in R software (Bates et al., 2014).

Multilevel Logistic Regression Model Building

Model 0 (null model). A baseline/null model was constructed for vegetarian status, a dichotomous variable. A null model does not include predictors but random intercept variance term for groups (congregations). The purpose of examining a null model was to determine how much of the variability in vegetarian status is accounted for by congregations.

To determine how much of the variance in vegetarian status can be explained by congregational level, the intra-class correlation was computed. There is a slight modification to the formula as the previous section, where the level-1 error

variance is assumed to have a standard logistic distribution, with a variance of $\pi^2/3$, as in the following formula (Rodriguez & Elo, 2003):

$$ICC = \frac{\sigma_{u_0}^2}{(\sigma_{u_0}^2 + \pi^2/3)}$$

where ICC is the intra-class correlation, $\sigma_{u_0}^2$ is the congregational-level variance.

Model 1. In this model the relationship between vegetarian status and demographics (age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether they are born into an Adventist family) were examined. The model is specific as below:

$$\begin{aligned} \text{Veg}_{ij} = & \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \\ & \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \\ & \beta_9(\text{Adventist Family})_{ij} + u_{0j} \end{aligned}$$

where Veg_{ij} is the log odds of being a vegetarian for individual i nested in the congregation j , γ_{00} is the intercept, β_{1-9} are the coefficients and u_{0j} is congregational-level error.

Models 2. Models 2 built on model 1 and added individual religious variables. In this section, only models including religious attendance are provided. Models including other religious variables are found in [Appendix M.2](#). The model is specified as below:

$$\begin{aligned} \text{Veg}_{ij} = & \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \\ & \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \\ & \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Religious Attendance})_{ij} + u_{0j} \end{aligned}$$

Models 3. Model 3 built on model 2 and included congregational conservativeness. The models are specified below:

$$\text{Veg}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Religious Attendance})_{ij} + \beta_{11}(\text{Congregational Conservativeness})_{ij} + u_{0j}$$

Model Fit

Akaike Information Criterion (AIC), and -2 log likelihood of the fitted models were compared. A better fit was indicated by reduced AIC and -2 log likelihood. Chi-square tests were conducted to compare deviances of different models.

3.7.7. Mediation Analysis

Path analysis, originally developed by Sewall Wright, a geneticist in 1920s, is an extension of multiple regression and is used to examine hypothesized casual connections between variables (Pedhazur, 1997). Similar to regression, path analysis is based on linear statistical models and is only valid when certain assumptions are met; regression methods assume a normal distribution while path analysis assumes multivariate normality (Suhr, 2008). Path analysis is a type of structural equation modelling (SEM), a family of multivariate statistical techniques that also include confirmatory factor analysis, structural regression models, latent growth modelling and so on (Kline, 2015).

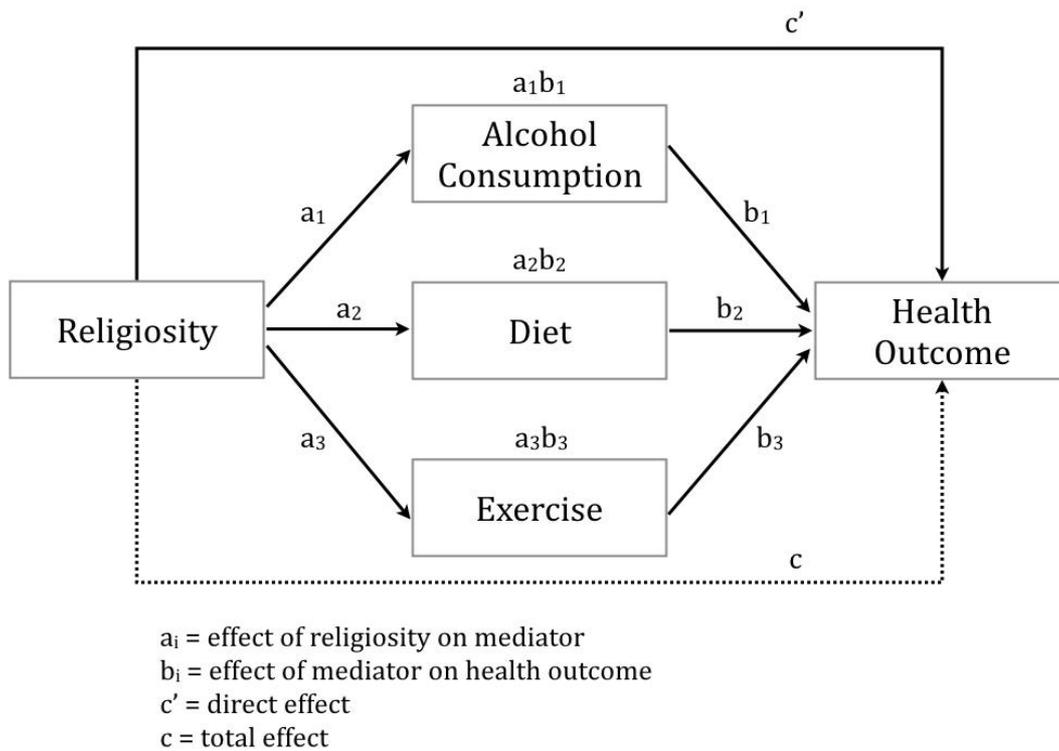
Path analysis is usually depicted with path diagram, a graphical representation of associations between variables (Wright, 1934, 1960). In a path diagram, exogenous variables are those that do not receive causal inputs from any other variable while

endogenous variables are those that receive one or more such causal inputs (Loehlin, 2004). Extraneous variables are the variance unexplained by the endogenous variables, such as measurement error (Kline, 2015).

A path analysis examines three types of effects: direct, indirect and total effects. Direct effect is the association between two variables through direct pathways in the path diagram without including the indirect effects (for example, the effects of Ex_1 on En_1 in Figure 5); indirect effect is the association between two variables mediated through other variables (for example, the effects of Ex_1 on En_2 through En_1), and total effect is the sum of direct and indirect effects of two variables (Loehlin, 2004).

In this study, first Pearson product-moment coefficients were calculated for correlations between religious, health behaviour (except alcohol consumption in the past 30 days) and health outcomes variables. Alcohol consumption in the past 30 days is a dichotomous variable and point-biserial correlation coefficients were calculated for correlation between alcohol consumption and other variables. Then path analysis was conducted using the *lavaan* package in R (Rosseel, 2012) to determine whether health behaviours (alcohol consumption, dietary habit and exercise) mediate the relationship between individual religiosity (religious attendance, private religious activities, intrinsic religiosity, and Sabbath-keeping) and health outcomes (systolic and diastolic blood pressure and blood glucose level), as shown in the path diagram in Figure 4 below. Twelve path analyses were performed.

Figure 4. Path diagram of the relationship between religiosity and health outcomes.



The indirect effect of religious variable on health outcome through the one of the health behaviour variables was calculated as the product of the path coefficient between the religiosity variable and the health behaviour variable (a_{1-3}) and the path coefficient between the health behaviour variable and health outcome (b_{1-3}). The overall indirect effect was the sum of all the indirect effects of religiosity and health outcome through health behaviour. The total effect of religiosity on health outcome (c) was the sum of overall indirect effect and direct effect (c'). For each path diagram, direct, indirect and total effects of religiosity on health outcomes were computed. All path analyses were controlled for age, gender, ethnicity, marital status, employment status, income, level of education, age of

conversion/baptism, and whether the participants were born into an Adventist family.

CHAPTER 4: SAMPLE PROFILE

This chapter presents the descriptive results of the participating congregations and participants. It contains five sections. The first section presents the demographics of the 574 participants. The second to sixth sections summarise the religiosity, diet, lifestyle factors and self-reported health status of the 574 participants.

4.1. Demographics of Participants

There were 607 returned questionnaires from church members, where 500 were hardcopies, and 107 were online questionnaires. Thirty-three questionnaires were excluded because the participants were below 18 years old, did not specify their age, were Adventists not residing in West Malaysia, or non-Adventists. Five hundred and seventy-four questionnaires from 45 congregations were available for analysis. The response rate, based on 750 eligible participants, was 76.5%, which was relatively low compared with the 90.0% and above response rates in Adventist Health Studies, 98.8% (Beeson et al., 1989; Butler et al., 2008), but relatively higher than other epidemiologic surveys (mean response rate about 60.0%) (Asch et al., 1997; Galea & Tracy, 2007). Table 4 shows the demographic characteristics of the participants (values are expressed as mean±standard deviation or percentage).

Table 4. Demographics of participants.

Variables	All	Males (n=253)	Females (n=321)
Age (years)	34.6±13.70	35.31±14.42	34.0±13.09
Ethnicity			
Chinese	54.0%	51.5%	56.0%
Indian	9.4%	10.4%	8.6%
Bumiputra	25.5%	24.0%	26.6%
Others	11.2%	14.2%	8.8%
Education			
Secondary school or less	37.1%	35.8%	38.1%
Diploma	25.7%	22.9%	28.0%
Bachelor's degree	30.0%	33.1%	27.6%
Graduate degree	7.1%	8.2%	6.3%
Marital status			
Never married	52.4%	54.8%	50.6%
Currently married	41.4%	42.5%	40.6%
Previously married	6.1%	2.7%	8.8%
Income			
Less than RM1000	23.5%	23.6%	23.5%
RM1001-2999	35.6%	30.9%	39.4%
RM3000-4999	23.2%	22.6%	23.6%
Above RM5000	17.7%	22.9%	13.5%
Employment (Yes)	60.0%	65.6%	55.6%
Age of baptism (years)	19.4±10.08	19.6±10.36	19.2±8.86
Born in Adventist family (Yes)	45.7%	46.2%	45.3%

The average age of the sample was 34.6 years, while the average age of baptism (joining the Seventh-Day Adventist Church) was 19.3 years. About half of the participants were Chinese, and a quarter were non-Malay Bumiputras². About 44% of the participants were male and about 62% of the sample had completed tertiary

² Non-Muslim natives of Sabah and Sarawak states of Malaysia

education, and 40% were currently married. Sixty per cent of the participants were employed. About 45% of them were born and raised by parent(s) who are Seventh-Day Adventists. There were no significant demographic differences between males and females.

4.2. Religiosity

There was no significant difference on most of the religious variable between males and females, with the exception of Sabbath-keeping (females scored higher), see Table 5.

Table 5. Religiosity of participants.

Variables	All	Males (n=253)	Females (n=321)
Religious attendance			
Less than once per week	10.4%	10.3%	10.4%
Once a week	48.6%	43.0%	53.1%
More than once per week	41.0%	46.7%	36.5%
Private religious activities			
Once or less than once per week	20.9%	20.0%	21.6%
More than once per week	79.1%	80.0%	78.4%
Intrinsic religiosity (3 = low, 15 = high)	14.0±1.52	14.0±1.51	14.1±1.53
Sabbath-keeping(4 = low, 24 = high)*	20.8±3.86	20.4±4.15	21.1±3.59

Note. Significant differences by gender: * $p < 0.05$

About 90% of the participants attend church at least once a week, and about 80% of them conducted private religious activities at least once a week. Their intrinsic religiosity and Sabbath-keeping scores were on the high side too.

4.3. Diet

Females had better dietary habit than the males, while both males and females were not significantly different in fruit and vegetable intake and vegetarian status (Table 6). The average daily fruit and vegetable intake of all participants was about five servings. About 40% (not shown in the table) of them consumed five or more servings of fruit and vegetable daily, compared to 7.5% of the general Malaysian population (Ministry of Health, 2011). However, the prevalence of vegetarianism among the participants of the current study (17.8%) was much lower than the Adventists in North America (35.8%) (Butler et al., 2008).

Table 6. Diet of participants.

Variables	All	Males (n=253)	Females (n=321)
Vegetarian status (yes)	17.8%	17.4%	18.1%
Average daily fruit and/or vegetable servings	4.8±2.32	4.9±2.56	4.6±2.10
Dietary habit (1= never, 4 = routinely)***	2.7±0.48	2.7±0.44	2.8±0.50

Note. Significant differences by gender: *** $p < 0.001$

4.4. Lifestyle Factors

Consistent with the findings from AHS-2 (Butler et al., 2008), the prevalence of alcohol drinking and smoking was low among the participants (Table 7). About 60% of the participants are lifetime alcohol abstainers; only about 6% of them are current drinkers (consumed alcohol in the past 30 days), compared with 12.8% of the general Malaysian population (Ministry of Health, 2011). More males consumed alcohol in the past and in the past 30 days than females. None of the

females are current smokers, and only 1.6% of males were current smokers, compared to 25% of the Malaysian population (Ministry of Health, 2011). Overall males exercised more than the females, and males also were engaged in significantly more strenuous exercise in a week.

Table 7. Lifestyle factors of participants.

Variables	All	Males (n=253)	Females (n=321)
Past alcohol consumption (yes)	39.8%	46.6%	34.4%
Past 12 months alcohol consumption (yes)*	16.3%	23.5%	10.7%
Past 30 days alcohol consumption (yes)*	6.0%	8.9%	3.8%
Smoking status (yes)	0.8%	1.7%	0%
Exercise			
Godin leisure activity score**	30.1±32.03	33.8±37.80	27.1±26.05
Strenuous exercise per week***	1.4±2.12	1.8±2.54	1.1±1.64
Moderate exercise per week	2.1±2.66	2.3±3.05	1.9±2.30
Mild exercise per week	2.4±2.66	2.2±2.80	2.5±2.53

Note. Significant differences by gender: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

4.5. Self-Reported Anthropometric Measurements and History of Diseases

Using the 23kg/m² as the cut-off point for overweight and obesity, 29.0% of the participants were pre-obese and 13.2% were obese (Table 8), compared to 33.4% pre-obese and 30.6% obese among the Malaysian population (Table 9) (Institute for Public Health, 2015; Ministry of Health, 2011). More females were underweight and more males were pre-obese.

Table 8. Self-reported health status.

Variables	All	Males (n=253)	Females (n=321)
BMI†*	22.7±4.23	23.2±4.34	22.3±4.11
Underweight (BMI<18.5)	13.4%	10.0%	16.3%
Normal (BMI=18.5-22.9)	44.8%	41.7%	47.2%
Overweight (BMI>23)			
Pre-Obese (BMI=23-27.5)	29.0%	34.8%	24.6%
Obese (BMI>27.5)	13.2%	13.6%	11.9%
Waist circumference (cm)***	77.3±14.63	80.3±14.04	74.9±14.66
Abdominal obesity††***	23.2%	15.9%	29.0%
Hip circumference (cm)*	88.8±19.05	86.5±19.30	90.6±18.61
Waist-to-hip ratio	0.9±1.05	1.0±0.96	0.9±1.11
Raised blood glucose/diabetes (yes)	5.3%	7.0%	3.9%
Raised blood pressure/hypertension (yes)*	11.1%	16.7%	6.7%

Note. Significant differences by gender: * $p<0.05$; *** $p<0.001$

†Categorized based on Management of Obesity, pg. 6

††Waist circumference >90cm for males and >80cm for females

Table 9. Percentage of underweight, normal weight, pre-obesity and obesity among Malaysians and Adventists in West Malaysia.

Ethnicity	Underweight (BMI<18.5)		Normal (BMI=18.5-23.0)		Pre-Obese (BMI=23.0-27.5)		Obese (BMI>27.5)	
	M'sia	Adv	M'sia	Adv	M'sia	Adv	M'sia	Adv
All	6.7	13.4	29.3	44.8	33.4	29.0	30.6	13.2
Chinese	8.3	16.5	34.4	46.5	35.4	28.3	21.9	8.8
Indian	4.6	11.5	33.1	42.0	33.1	32.0	43.5	14.5
Bumiputras	6.1	9.0	35.8	46.0	35.8	25.4	30.7	19.6

M'sia=Malaysia; Adv=Adventist

Note. Extracted from Institute for Public Health. (2015). *National Health and Morbidity Survey 2015, Vol II: Non-Communicable Diseases, Risk Factors and Other Health Problems*. Ministry of Public Health.

Males had significantly lower hip circumference than the females. The overall and by gender prevalence of abdominal obesity (overall=23.2%; males=15.9%; females=29.0%) of the participants was about half of the prevalence of the Malaysian population (overall=48.6%, males=38.2%, females=60.2%) (Institute for Public Health, 2015). Similar to the Malaysian population, in this study females had significantly higher percentage of abdominal obesity compared with males.

Since Indians and Malays have higher prevalence of obesity (Institute for Public Health, 2015), it is possible that the low obesity prevalence among the participants was due to the fact that the majority of the participants were Chinese and there was no Malay participant and very few Indian participants. However, when compared by ethnicity, the Adventists in West Malaysia have lower BMI; 44.8% of the Adventists in West Malaysia have normal body weight, compared with 29.3% of Malaysians (Table 9) (Institute for Public Health, 2015).

The Adventists in West Malaysia had slightly lower prevalence of self-reported diabetes and hypertension, at 5.3% and 11.1%, compared with the Malaysian population, at 8.3% and 13.1% (Institute for Public Health, 2015). However, since the diseases were self-reported, there might be cases where the participants were unaware of their conditions. In addition, the low prevalence of diabetes and raised blood pressure/hypertension might be due to age; most of the participants were below 60 years old and the diseases are more common among those who are more senior.

CHAPTER 5: INDIVIDUAL RELIGIOSITY AND DIET

5.1. Introduction

This chapter reports the finding of the statistical analysis on the relationship between individual religiosity and diet. It includes a published paper based on the results from multiple linear and logistic regression analyses on the relationship between religiosity and diet. Additional multiple regression analysis was conducted and the results are presented. The paper addressed the first research question: What is the relationship between individual religiosity and healthy eating among Seventh-day Adventist in West Malaysia? It reported the results from the data of 574 participants.

5.2. Declaration for Thesis Chapter 5

Declaration by candidate

In the case of Chapter 2, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
<ul style="list-style-type: none">• Collected and analysed data• Wrote the draft• Designed the study	70

The following co-authors contributed to the work:

Name	Nature of contribution	Extent of contribution (%)
Daniel D. Reidpath	Provided advice in data collection and analysis and editorial input	15
Carina K. Y. Chan	Provided advice in data collection and analysis and editorial input	15

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work*.

Candidate's Signature	Date

Main Supervisor's Signature	Date



Religiosity, dietary habit, intake of fruit and vegetable, and vegetarian status among Seventh-Day Adventists in West Malaysia

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Abstract Religion has been shown to be salutary on health, and a possible link between religion and positive health outcomes is diet. Research has shown that religiosity is associated with better diet but most studies were conducted in a multi-denominational context, which might be confounded with theological differences. This study examined the relationship between religiosity and diet within a homogenous group of believers. Data from survey of 574 Seventh-Day Adventists residing in West Malaysia, aged 18–80, were analyzed using multiple regressions. While none of the religious variables were significantly associated with fruit and vegetable intake, a higher level of religiosity was associated with a better dietary habit and vegetarian status. The mixed relationship between religiosity and diet suggest that further research is needed to explore how religion might influence the diet of adherents.

Keywords Religion · Religiosity · Spirituality · Diet · Fruit and vegetable intake · Vegetarian

Introduction

Diet is an integral part of health promotion and disease management. It plays an important role in maintaining health and in the development of non-communicable diseases (NCDs), which are responsible for 63 % or about 36 million deaths globally (World Health Organization 2003, 2009). About 30–40 % of cancers are preventable by adopting a healthy lifestyle and diet (Tienboon 2012). High saturated and trans-fat intake has been shown to be positively associated with an increased risk of cardiovascular diseases (Kromhout 2000). About 1.7 million deaths worldwide are attributed to low fruit and vegetable consumption (World Health Organization 2013a).

Research has shown that a higher level of religiosity and/or spirituality (R/S) is associated with better mental and physical health (Chatters 2000; Levin 1994), including lower levels of stress (Chang et al. 2001; Larson 2006; Oman 2006), lower levels of depressive and suicidal symptoms (Nisbet 2000; Van Voorhees 2008), higher levels of well-being, self-esteem and optimism (Crabtree and Pelham 2009; Koenig and Vaillant 2009; Krause 2003, 2006), lower all-cause mortality (Kim et al. 2014; Strawbridge et al. 1997), and a lower risk of NCDs such as cardiovascular diseases (Burazeri 2008; Obisesan et al. 2006) and cancers (Gillum and Williams 2009; Jaffe 2005). In addition, R/S is also positively associated with a lower risk of obesity (Ayers et al. 2010) and hypertension (Gillum and Ingram 2006; Levin and Vanderpool 1989)—two major risks factors of NCDs.

Many mechanisms have been proposed to explain the positive association between R/S and better health outcomes and one of the proposed mechanisms is through the practice of health-promoting behaviors and avoidance of

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health-risk behaviors (George et al. 2002; Levin 1994). Many religions hold that the human body is sacred and needs to be cared for, hence the many prohibitions against physically harmful behaviors that could inhibit spiritual growth. Health-promoting behaviors that are conducive to spiritual development are encouraged. Supporting this idea, it has been found that a higher level of R/S is associated with lower prevalence of health-risk behaviors such as smoking (Blay et al. 2008; Koenig et al. 1998), alcohol consumption (Michalak et al. 2007; Patock-Peckham et al. 1998), substance abuse (Miller et al. 2000; Steinman 2008), and a higher prevalence of health-promoting behaviors such as physical activity (Strawbridge et al. 2001).

One of the main health-promoting behaviors found in many religions is the adoption of a better diet (Tan et al. 2014). Many religions have specific dietary laws, which fall into two categories: "a temporal abstinence from all or certain foods (fasting)" and "stable and distinctive dietary habits that differ from the general population" (Sabate 2004). For example, Hindus avoid beef and are vegetarians on certain days; Muslims fast during Ramadan and avoid unclean meat such as pork; Buddhists monks and nuns are vegans; Catholics avoid meat during Lent fasting. Even in religions that do not have specific dietary laws, such as Protestantism in general, the teaching that the body is "the holy temple of God" (1 Corinthians 6:19) might encourage the believers to adopt a better diet. The religious dietary laws are practiced mainly for spiritual development rather than health *per se*; however, since they are being practiced over the long term, they could have an influence on diet-related NCDs. For example, the Seventh-day Adventist Church and the Church of Jesus Christ of the Latter-day Saints both encourage their believers to consume more fruit and vegetable and less fat, and there is evidence that their adherents enjoy better physical health and longer lifespans than the general population (Enstrom 1978; Mills et al. 1994). A higher level of R/S was shown to be associated with higher intake of fruit and vegetable (Baruth et al. 2011; Debnam et al. 2012; Lytle et al. 2003) and lower intake of overall and saturated fat (Hart et al. 2007), both of which are associated with lower risk of cardiovascular diseases; regular breakfast (Wallace and Forman 1998) and lower soft drinks consumption among adolescents (Pitel et al. 2012); healthful nutrition (Chliaoutakis et al. 2002; Homan 2010; Reid and Smalls 2004); healthy food choices and eating patterns (Rew et al. 2007); and better healthy eating index (Sahyoun and Zhang 2005).

However, non-significant relationship between R/S and diet has also been reported in other studies. In a recent systematic review, about half of the 46 studies included in the review showed no significant relationship between R/S and the intake of fruit, vegetable and fat (Tan et al. 2013). In a study of Jewish adolescents' health behaviors, R/S was

not associated with regular breakfast, soft drinks consumption, and fast food consumption (Benjamins 2012). A web-based study of Buddhists in the U. S also found no association between Buddhist devoutness and adopting a vegetarian diet (Wiist et al. 2012). There are also studies that showed mixed or negative association between R/S and diet. One study reported that monthly religious attendance was associated with reduced odds of sound diet quality (Hill et al. 2006). In another study African Americans who prayed regularly and placed more importance in religion were more likely to consume fast food, while those who attend religious services more were less likely to consume fast food (Dodor 2012).

The contradictory findings warrant further research to investigate the relationship between R/S and diet. Most of the previous R/S and diet studies were conducted in a multid denominational/multi-religious setting, where respondents from more than one religious group or denominations within a religion were included, and this is a potential confounder. The very few studies conducted among single denomination were on Jews. The use of multid denominational/multi-religious sample might lead to different understanding and interpretation of the questionnaire. Items related to R/S among the heterogeneous respondents may have different interpretations, such as the notion of religious attendance for Buddhists who do not have a calendar of weekly visits and Christians who do. Even within the same religion, a religious construct could be interpreted differently by members of different denominations. For the Seventh-Day Adventists and the Seventh-Day Baptists, the Sabbath falls on Saturday, while for many other Christian denominations it falls on Sunday. These kinds of issues would need to be carefully monitored in any questionnaire used across heterogeneous denominations. Single denominational studies, on the other hand, eliminates the need to control for potential denominational differences (Lee et al. 2009).

The purpose of this study was to investigate the relationship between R/S and diet in a single denomination. The target population was the Seventh-Day Adventist currently residing in West Malaysia. The Adventists are a group of conservative Christians who are supposed to follow strict dietary guidelines, and healthy eating is part of the doctrinal teaching of the Church. Unclean meat such as pork and shellfish, recreational drugs, smoking, and alcohol are proscribed, and the members are encouraged to consume more fruit, vegetable and nuts, and if possible, to be vegetarians. Although considerable diet and health research has been done on the Adventists (Le and Sabate 2014; Pettersen et al. 2012) and some have tried to investigate the relationship between R/S and health among the Adventists in recent years (Lee et al. 2009), the results of these studies with the Adventists were mainly from North America and

developed countries, as are most other R/S and health studies. There was no study on R/S and diet in Malaysia, a multiracial developing country, which has different cultures and dietary practices from developed countries. The current study was the first to examine the relationship between R/S and diet among Adventists outside a North American context.

Methods

This was a cross-sectional study based on questionnaire responses to items about R/S, diet, and socio-demographics.

Sample

The sampling frame of the study was all baptized Seventh-Day Adventists who were above 18 years old and were currently residing in West Malaysia. Potential respondents were recruited through the pastors of the congregations. The participants were given a questionnaire by their pastors or the researchers through personal communication and an online version was also available. The participants of online questionnaire were recruited through social media and emails.

Measures

Religious variables

Four dimensions of R/S were included in the study: organizational religiosity, non-organizational religiosity, intrinsic religiosity and Sabbath-keeping. The first three dimensions were measured by the Duke University Religion Index (DUREL)—a five-item scale. The organizational religiosity subscale is composed of a single item that measures the frequency of religious attendance. The non-organizational religiosity subscale is composed of a single item that measures the frequency of private religious activities such as prayers, reading of religious literature, listening or watching religious program etc. The intrinsic religiosity subscale is composed of three items that measure the degree of religious motivation. The DUREL has moderate internal consistency (Cronbach's $\alpha = 0.60$, in this study). For ease of understanding, the terms "religious attendance" and "private religious activities" are used in the remaining sections of the paper. Sabbath-keeping was measured by the Secular Activities on Sabbath scale, one of the three subscales of the Sabbath-Keeping Scale (Lee et al. 2006, April). The Adventist Church encourages its members to keep the Sabbath by not engaging in secular activities. The Secular Activities on Sabbath contains four

items that measure how much a participant engages in secular activities (shopping, reading secular magazines, attending secular concert or watching movie, and watching or listening to news programs) during Sabbath. It is scored on a 6-point response scale from every Sabbath to never. The scale was reversed coded from 1 to 6 so that a higher score indicates better Sabbath-keeping. The Secular Activities on Sabbath subscale has been used to study the relationship between Sabbath-keeping and health (Supervill et al. 2013) and has a good internal consistency (Cronbach's $\alpha = 0.80$, in this study).

Dietary variables

Diet was measured using a dietary habit scale, a measure of fruit and vegetable intake, and self-identification of vegetarian status. Dietary habit was measured by using the Nutrition subscale of Health Promotion Lifestyle Profile II (HPLPII). The Nutrition subscale contains nine items that assess various aspects of dietary habit such as choosing a low-fat, low-salt and low-sugar diet, regular consumption of fruit and vegetable, eating breakfast etc. The items are scored on a 4-point response scale (never, sometimes, often, routinely), and a higher score indicates a higher frequency. A total score for the subscale was obtained by calculating the mean of the responses to the nine items (Walker et al. 1995). The internal consistency of the Nutrition Subscale is acceptable (Cronbach's $\alpha = 0.71$, in this study). Fruit and vegetable intake was measured with WHO STEPS instrument (World Health Organization 2013b). The participants were asked "In a typical week, on how many days do you eat fruit/vegetable?" and "How many servings of fruit/vegetable do you eat on the day you eat fruit?" A sum of fruit and vegetable intake was obtained by adding the number of servings of fruit and vegetable. The participants were also asked to identify their dietary practices as vegan/vegetarian or non-vegetarian.

Demographic variables

The participants were asked about their age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether they were born into an Adventist family.

Analysis

The Pearson product-moment correlations were computed to examine the relationship among the different religious variables. Multiple regression analysis was conducted to analyze the relationship between religious variables and dietary variables. To examine the independent effect of the religious variables, they were entered into the model

Table 1 Demographics

Variables	All	Males (n = 253)	Females (n = 321)
<i>Demographics</i>			
Age (years)	34.6 ± 13.70	35.31 ± 14.42	34.0 ± 13.09
<i>Ethnicity</i>			
Chinese (%)	54.0	51.5	56.0
Indian (%)	9.4	10.4	8.6
Indigenous (%)	25.5	24.0	26.6
Others (%)	11.2	14.2	8.8
<i>Education</i>			
Secondary school or less (%)	37.1	35.8	38.1
Diploma (%)	25.7	22.9	28.0
Bachelor's degree (%)	30.0	33.1	27.6
Graduate degree (%)	7.1	8.2	6.3
<i>Marital status</i>			
Never married (%)	52.4	54.8	50.6
Currently married (%)	41.4	42.5	40.6
Previously married (%)	6.1	2.7	8.8
<i>Income</i>			
Less than RM1000 (%)	23.5	23.6	23.5
RM1001-2999 (%)	35.6	30.9	39.4
RM3000-4999 (%)	23.2	22.6	23.6
Above RM5000 (%)	17.7	22.9	13.5
Age of baptism (years)	19.4 ± 10.08	19.6 ± 10.36	19.2 ± 8.86
Born in Adventist family (yes) (%)	45.7	46.2	45.3
<i>Religious variables</i>			
Religious attendance	4.3 ± 0.79	4.3 ± 0.83	4.2 ± 0.76
Private religious activities	4.7 ± 0.73	4.7 ± 0.66	4.6 ± 0.78
Intrinsic religiosity (3 = low, 15 = high)	14.0 ± 1.52	14.0 ± 1.51	14.1 ± 1.53
Sabbath-keeping (4 = low, 24 = high)*	20.8 ± 3.86	20.4 ± 4.15	21.1 ± 3.59
<i>Dietary variables</i>			
Vegetarian status (yes) (%)	17.8	17.4	18.1
Average daily fruit and/or vegetable servings	4.8 ± 2.32	4.9 ± 2.56	4.6 ± 2.10
Dietary habit (1 = never, 4 = routinely)***	2.7 ± 0.48	2.7 ± 0.44	2.8 ± 0.50

Significant differences by gender: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

simultaneously. Multiple linear regressions were conducted to analyze the relationship between religious variables and dietary habit and fruit and vegetable intake. Logistic regression was used to analyze the relationship between religious variables and vegetarian status and odds ratios were obtained. All regressions were controlled for age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether one was born into an Adventist family. About 10 % of the cases included some missing data. Multiple imputation was conducted to overcome this. It is a statistical technique to impute incomplete data and has been shown to reduce bias and increase efficiency compared to

listwise deletion (Honaker et al. 2011). Unlike other procedures for handling missing data, multiple imputation does not assume that the data are randomly missing (Tabachnick and Fidell 2013). Five imputed datasets were obtained and each dataset was analyzed separately and their results were pooled according to Rubin's rule (Rubin 2004).

To determine the 95 % confidence intervals for the odds ratio, bootstrapping was conducted 1000 times on each of the five imputed datasets. The means of coefficients were obtained from the five sets of bootstrap samples and sorted in ascending order. The 25th and 975th values were exponentiated to obtain the 95 % confidence interval.

Table 2 Zero-order correlation coefficients among religious variables

	Religious attendance	Private religious activities	Intrinsic religiosity	Sabbath-keeping
Religious attendance	1.00			
Private religious activities	0.30***	1.00		
Intrinsic religiosity	0.11**	0.32***	1.00	
Sabbath-keeping	0.18***	0.20***	0.19***	1.00

Significant differences: ** $P < 0.01$; *** $P < 0.001$

Bootstrapping was employed because it does not assume normality of the sampling distribution (Efron and Tibshirani 1994; Mooney and Duval 1993).

Data were analyzed with R software.

Results

Demographics

There were 607 returned questionnaires, where 500 were hardcopies, and 107 were online questionnaires. Thirty-three questionnaires were excluded because the participants were below 18 years old, did not indicate their age, or were Adventists not residing in West Malaysia, or non-Adventists. Five hundred seventy-four questionnaires from 45 Adventist congregations in West Malaysia were available for analysis.

The average age of the sample was 34.6 years, while the average age of baptism (joining the Seventh-Day Adventist Church) was 19.4 years (Table 1). About half of the participants were Chinese, and a quarter was indigenous Malaysians.¹ About 44 % of the participants were male and about 63 % of the sample had completed tertiary education, and about 40 % were currently married. About 45 % of them were born and raised by parent(s) who are Seventh-Day Adventists.

There were no significant demographic differences between males and females. There were also no significant differences on religious variable between males and females, with the exception of Sabbath-keeping (females scored significantly higher). Females had better dietary habit than the males, while there was no significant difference in fruit and vegetable intake and vegetarian status. The average daily fruit and vegetable intake of all participants was about five servings. Forty-two percent of the participants consumed more than five servings of fruit and vegetable daily (not shown in table). About 18 % of the participants were vegans or vegetarians.

¹ Non-Malay Bumiputras.

Correlations

Table 2 presents the correlations among the four religious variables. All correlations were significant, with most being positive and small, except the correlations between religious attendance and private religious activities ($r = 0.30$), and between private religious activities intrinsic religiosity ($r = 0.32$), which were moderate.

Regressions

Regression of dietary habit on religious variables was conducted (Table 3). Results are shown for the analysis for the full scale; however, we also checked the results using the dietary habit scale after the fruit and vegetable items were removed. It made no substantive difference to the results, and we retained the full scale to remain consistent with the extant literature. Intrinsic religiosity and Sabbath-keeping were positively associated with better dietary habit. None of the religious variables were significantly associated with fruit and vegetable intake (Table 4). All religious variables, except private religious activities, were significantly associated with vegetarian status. Those who had higher religious attendance had 1.6 times higher odds of being vegetarians; and those who had higher intrinsic religiosity and better Sabbath-keeping had 1.3 times higher odds of being vegetarians (Table 5).

It should be noted that age of baptism and born in Adventist family were significantly associated with dietary habit. Adventists who were baptized earlier and born in Adventist family were more likely to have a better diet. However, age of baptism and born in Adventist family were not significantly associated with fruit and vegetable intake and vegetarian status.

Discussions

The current study showed that the relationship between R/S and diet among Seventh-Day Adventists in West Malaysia was mixed. While none of the religious variables were significantly associated with fruit and vegetable intake, a higher level of R/S was associated with a better dietary

Table 3 Multiple linear regression of dietary habit on religious variables

Variables	B	SE	β	t	R ²
Religious attendance	0.029	0.032	0.039	0.911	0.156***
Private religious activities	-0.014	0.053	-0.012	-0.280	
Intrinsic religiosity	0.035	0.018	0.112	2.603**	
Sabbath-keeping	0.015	0.010	0.118	2.830**	
Age	0.006	0.021	0.173	2.752**	
Gender					
Male					
Female	0.123	0.040	0.128	3.125**	
Ethnicity					
Chinese					
Indians	-0.112	0.069	-0.261	-1.621	
Indigenous [†]	0.050	0.052	0.063	0.962	
Others	-0.085	0.067	-0.175	-1.346	
Marital status					
Never married					
Currently married	-0.018	0.066	-0.039	-0.325	
Previously married	0.074	0.094	0.076	0.788	
Education					
Secondary school or less					
Diploma	0.113	0.243	2.388	2.250*	
Bachelor's	0.120	0.052	0.125	2.366*	
Graduate	0.113	0.085	0.154	1.394	
Income					
Less than RM1000					
RM1001-RM2999	-0.023	0.055	-0.020	-0.425	
RM3000-4999	0.088	0.093	0.280	1.479	
Above RM5000	0.131	0.153	1.065	1.945	
Employment					
Employed					
Unemployed	0.029	0.326	0.847	0.676	
Age of baptism	-0.009	0.002	-0.009	-3.624***	
Born in Adventist family					
No					
Yes	0.102	0.050	0.238	2.216*	

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

[†] Controlled for covariates (age, gender, ethnicity, marital status, income, employment, education, age of baptism, born in Adventist family or not)

habit (intrinsic religiosity and Sabbath-Keeping) and vegetarian status (all religious variables except private religious activities). Diet is “the kinds of food that a person... habitually eats” (“Diet” 2015), and the dietary habit scale examined diet more holistically; it measured nine dimensions of a diet and not just intake of certain food groups. Compared with fruit and vegetable intake and vegetarian status, the positive association between R/S and dietary habit scale was more informative and comprehensive.

Compared with other denominations, religions or the general population, Adventists consumed more fruit and

vegetable (Alexander et al. 1999; Kent and Worsley 2009; Kuczmarski et al. 1994; Sabate et al. 1990). However, it was unknown whether among the Adventists the practice is adopted homogenously. The current study showed that there was no significant relationship between R/S and fruit and vegetable intake, and this was consistent with many previous studies (Hart et al. 2004; Benjamins 2012). It might be that the regular consumption of fruit and vegetable is inherent in the doctrine of the Seventh-Day Adventist Church; Adventists would have known about the importance of regular consumption of fruit and veg-

Table 4 Multiple linear regression of fruit and vegetable intake on religious variables

Variables	B	SE	β	t	R ²
Religious attendance	0.180	0.160	0.050	1.126	0.068
Private religious activities	-0.306	0.264	-0.054	-1.157	
Intrinsic religiosity	0.094	0.069	0.061	1.363	
Sabbath-keeping	0.011	0.029	0.018	0.420	
Age	0.006	0.022	0.037	0.556	
Gender					
Male					
Female	-0.222	0.202	-0.048	-1.104	
Ethnicity					
Chinese					
Indians	-0.354	0.360	-0.170	-0.999	
Indigenous [†]	-0.369	0.264	-0.097	-1.398	
Others	0.906	0.324	0.381	2.796	
Marital status					
Never married					
Currently married	-0.397	0.285	-0.175	-1.401	
Previously married	-0.672	0.482	-0.142	-1.394	
Education					
Secondary school or less					
Diploma	0.057	0.530	0.243	0.219	
Bachelor's	0.364	0.259	0.078	1.408	
Graduate	1.010	0.416	0.282	2.440	
Income					
Less than RM1000					
RM1001-RM2999	-0.091	0.277	-0.016	-0.329	
RM3000-4999	-0.078	0.316	-0.051	-0.256	
Above RM5000	-0.214	0.393	-0.356	-0.622	
Employment					
Employed					
Unemployed	0.227	0.518	1.340	1.017	
Age of baptism	-0.010	0.012	-0.002	-0.839	
Born in Adventist family					
Yes					
No	0.211	0.237	0.101	0.896	

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

[†] Controlled for covariates (age, gender, ethnicity, marital status, income, employment, education, age of baptism, born in Adventist family or not)

etable through Bible studies before they were baptized and joined the Church, and many are already practicing it regardless of R/S, as shown by 40 % of Adventists who are consuming five or more than five servings of fruit and vegetable daily. This seems to support that the regular consumption of fruit and vegetable is practiced fairly homogenously among the Adventists, at least in West Malaysia, regardless of R/S. The insignificant prediction in the present study is likely due to ceiling effect.

Intrinsic religiosity is characterized as religion that is an end in itself; intrinsically motivated individuals *live* their

religion, as compared to extrinsically motivated individuals who *use* their religion as a means to an end, for example, to seek social networks, status, security and comforts etc. (Allport and Ross 1967; Masters 2013). People who exhibit high extrinsic religiosity are more likely to conform to social norm rather than religious teachings. The other three religious variables included in this study were religious attendance (how often one attends religious services); private religious activities (how often one conducts personal prayers, reads religious literature etc.); and Sabbath-keeping, which is the observance of the seventh day (Saturday)

Table 5 Logistic regression of vegetarian status on religious variables

Variables	B	SE	Odds ratio (CI)
Religious attendance	0.45	0.23	1.6 (1.05,2.49)*
Private religious activities	0.03	0.41	1.0 (0.52,2.44)
Intrinsic religiosity	0.27	0.22	1.3 (1.04,1.79)*
Sabbath-keeping	0.25	0.24	1.3 (1.16,1.54)***
Age	-0.01	0.07	1.0 (0.95,1.01)
Gender			
Male			
Female	-0.02	0.26	1.0 (0.59,1.71)
Ethnicity			
Chinese			
Indians	-0.59	0.53	0.6 (0.19,1.29)
Indigenous [†]	-1.30	0.43	0.3 (0.11,0.55)**
Others	0.15	0.39	1.2 (0.53,2.39)
Marital status			
Never married			
Currently married	0.42	0.49	1.5(0.74,3.37)
Previously married	0.51	0.61	1.7 (0.35,6.81)
Education			
Secondary school or less			
Diploma	0.37	2.16	1.4 (0.75,2.96)
Bachelor's	0.68	0.33	2.0 (1.10,4.28)*
Graduate	0.86	0.49	2.4 (0.83,6.40)
Income			
Less than RM1000			
RM1001-RM2999	0.30	0.36	1.3 (0.66,2.69)
RM3000-4999	-0.54	0.81	0.6 (0.21,1.24)
Above RM5000	-0.44	1.03	0.6(0.24,1.55)
Employment			
Employed			
Unemployed	-0.04	2.10	1.0 (0.52,1.77)
Age of baptism	-0.01	0.02	1.0 (0.96,1.02)
Born in Adventist family			
Yes			
No	0.45	0.34	1.6 (0.91,2.71)

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

[†] Controlled for covariates (age, gender, ethnicity, marital status, income, employment, education, age of baptism, born in Adventist family or not)

as sacred where the day is devoted to the pursuit of religious-related activities such as reading religious literature, attending religious services, listening to or watching religious program, visiting the sick, while secular activities

such as working, shopping, listening to or watching non-religious programs are avoided (Superville et al. 2014).

In the current study, while higher intrinsic religiosity and better Sabbath-keeping were positively associated with

a better dietary habit, there was no significant relationship between religious attendance, private religious activities and dietary habit. Religious attendance and private religious activities are the behavioral aspects of religion that could be practiced by individuals who are motivated intrinsically and extrinsically. One could be attending religious services and yet not keeping the Sabbath when they are not in the sight of other congregational members, and private religious activities could be practiced by those who are extrinsically motivated because of utilitarian purposes (e.g. to ask for personal gains from God). Thus, high religious attendance and more private religious activities do not necessarily imply that an Adventist is convinced by the Adventist health message to practice a better diet, even though adopting and maintaining a healthy diet is encouraged by the Church. In contrast, a higher score of Sabbath-keeping is more likely to be manifested among those who are motivated intrinsically. Adventists who had higher intrinsic religiosity and Sabbath-keeping scores might have "internalized" their religion and are more convinced by the notion that the body is the "holy temple of God" (1 Corinthians 6:19), motivating better dietary practice.

Note that even though intrinsic religiosity and Sabbath-keeping were positively associated with a better dietary habit, their coefficients were rather small, indicating a significant but small effect. This might be due to the choice of single-denominational sample that was already exposed to healthy eating. Thus, an increase of R/S score was associated with a minor increase of dietary habit score.

While Adventists who practiced a good dietary habit had higher intrinsic religiosity and kept the Sabbath better, the vegetarian Adventists had higher scores in both the overt behaviors of R/S (religious attendance) and the non-overt aspects of R/S (intrinsic religiosity and Sabbath-keeping). Religious attendance, even though not significantly associated with dietary habit and fruit and vegetable intake, was the strongest predictor of vegetarianism among the Adventists in West Malaysia. Religious attendance is one of the widely used religious variable in R/S and health research and appears to be a strong predictor of health (Levin and Vanderpool 1987; Williams 1994). As in other religious variables, one of the proposed links between religious attendance and positive health outcomes is the practice of health-promoting behaviors and avoidance of health risk behaviors. In fact, frequent attenders tend to exhibit better health behaviors such as quitting smoking and become more physically active (Strawbridge et al. 2001), and lower rates of heavy drinking and smoking (Hill et al. 2006). Religious attendance might have an impact on health behaviors due to frequent exposure of attendees to denominational/religious health norms and activities, doctrine related to health, and higher social support because of

friendship within a congregation (Hill et al. 2006). Instead of just practicing a healthier diet, the frequent attenders in this study might be more exposed to the vegetarian message of the Church and vegetarian-related practices (potluck, health promotion activities), and hence more likely to adopt vegetarianism. In addition, Adventists who attend religious services regularly are also more likely to receive social support in initiating and maintain a vegetarian diet. Their vegetarian behavior is more likely to be reinforced through encouragement from the church.

Some limitations should be noted in this study. First it included only four dimensions of R/S, which is a multi-dimensional construct. Other important R/S measures, such as religious coping and religious support, were not included in this study. Second, the study is cross-sectional and no causal association could be indicated. While it is more likely that R/S precedes better dietary habit and vegetarianism rather than vice versa, it is possible that Adventists who practice healthy lifestyle are more likely to be drawn to attend church more and are more religious, rather than religion *per se* that have a positive influence on lifestyle. In addition, some other variables may be affecting this relationship too. Second, this study was based on self-reported R/S and diet, which might have led to recall bias as well as social desirability bias. Third, even though there is official statistics about the membership of Adventists in West Malaysia, the record has not been updated regularly and the exact number of Adventists in West Malaysia is unknown. Efforts have been made to recruit as many Adventists in West Malaysia as possible. However, those who refused to or did not participate might have different characteristics than those who participated. Finally, this study included three dimensions of diet, none of which was a detailed record of dietary intake. Dietary record, the "golden standard" in dietary research where the respondents record all food and beverage consumed within a period (Thompson and Byers 1994), was not used in this study.

Taking into considerations of the limitations of the current study, future research should include other dimensions of R/S such as religious coping and religious support and use better dietary measure to shed more light on the relationship between R/S and diet. Longitudinal studies can be employed to investigate how diet changes over time in relation to R/S. One of the strengths of this study was the use of singledenomination, which removed the need to control for denominational differences. The results of the study showed that even within a single denomination, R/S still play a role in the adoption of a healthy diet. Similar singledenominational studies conducted on other religions or Christian denomination, especially those that have specific dietary guidelines such as Mormonism and Islam, might also help in understanding the relationship between R/S and diet.

Despite its limitations, the current study showed a connection between R/S and diet. Given that religion is considered important by many people around the world, especially those from Asian and Africa (Crabtree and Pelham 2009), and many of them are likely to be following the dietary guidelines required by their religions, religion could be a potential channel to promote a healthy diet. In fact, many faith-based health promotion projects have been conducted successfully (Campbell et al. 1999; McNabb et al. 1997; Yanek et al. 2001). The study of R/S and diet may lead to more effective interventions.

Compliance with ethical standards

Conflict of interest Min-Min Tan, Carina K.Y. Chan and Daniel D. Reidpath declare that they have no conflict of interest.

Human and animal rights and Informed consent All procedures followed were in accordance with ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

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5.3. Additional Regression Analysis

In the paper, multiple regressions were conducted by entering the four religious variables into one regression model. My original approach was to enter the religious variables into separate regression models. However, the journal editor required that the religious variables to be entered into one regression model in order to examine the independent effects of the religious variables. Koenig and Bussing (2010) and Koenig (2011) recommend separate and independent analysis of the different religious variables to avoid the problem of multi-collinearity (see Sections 3.4.3 and 3.7.4.1). I included the original analytic approach here to examine the different religious measures.

5.3.1. Results

Intrinsic religiosity and Sabbath-keeping were positively associated with better dietary habit before and after controlling for covariates (Table 10). None of the religious variables were significantly associated with fruit and vegetable intake (Table 11). All religious variables were significantly associated with vegetarian status (Table 12). After controlling for covariates, those who attended religious gatherings once a week had 4.5 times higher odds of being vegetarians than those who attended less than once per week; those who attended religious gatherings more than once a week had seven times higher odds of being vegetarians than did those who attended less than once per week; and those who conducted private religious activities more than once per week had 2.1 times higher odds of being vegetarians than did those who conducted private religious activities less than

once per week (Table 12). Intrinsic religiosity and Sabbath-keeping had slightly increased significant odds ratios, 1.5 and 1.3 respectively (Table 12).

For religious attendance, there was a significant difference in vegetarian status for those attending once a week or more. The confidence intervals were, however, very wide, indicating, for example the Adventists attending one per week had odds of being vegetarians between 1.3 times and more than 17.6 times greater than those who attend less than once per week. An examination of the distribution of bootstrapped results showed a smooth gradient of results up to 17.6 (for attendance once per week, and 29.6 for attendance more than once per week).

The results from the published paper and the additional analysis were similar, with the exception of religious attendance and private religious activities and the interpretation of the results were substantially similar too. Thus, the discussions will not be repeated.

Table 10. Multiple linear regression of dietary habit on religious variables.

Variables	Bivariate					Multivariate [†]				
	B	SE	β	t	R ²	B	SE	β	t	R ²
Religious attendance										
Less than once per week										
Once a week	0.040	0.071	0.054	0.584	0.008	0.024	0.069	0.032	0.358	
More than once per week	0.115	0.070	0.156	1.662		0.085	0.068	0.088	1.254	0.129***
Private religious activities										
Less than once per week										
More than once per week	0.096	0.050	0.082	1.972	0.007	0.066	0.049	0.056	1.392	0.128***
Intrinsic religiosity	0.052	0.015	0.165	4.010***	0.0274***	0.042	0.016	0.134	3.303**	0.142***
Sabbath-keeping	0.021	0.013	0.172	4.176***	0.0297***	0.018	0.012	0.142	3.495***	0.144***

Note. **p<0.01; ***p<0.001

[†]Controlled for covariates (Age, gender, ethnicity, marital status, income, employment, education, age of baptism, born in Adventist family or not)

Table 11. Multiple linear regression of fruit and vegetable intake on religious variables.

Variables	Bivariate					Multivariate [†]				
	B	SE	β	t	R ²	B	SE	β	t	R ²
Religious attendance										
Less than once per week										
Once a week	-0.391	0.331	-0.109	-1.186	0.014	-0.448	0.330	-0.125	-1.358	0.070
More than once per week	0.178	0.336	0.050	0.236		0.005	0.339	0.001	0.015	
Private religious activities										
Less than once per week										
More than once per week	0.091	0.238	0.016	0.382	0.000	-0.092	0.239	-0.016	-0.383	0.061
Intrinsic religiosity	0.070	0.064	0.046	1.105	0.002	0.081	0.065	0.053	1.261	0.064
Sabbath-keeping	0.022	0.028	0.036	0.862	0.001	0.016	0.029	0.027	0.636	0.062

[†]Controlled for covariates (Age, gender, ethnicity, marital status, income, employment, education, age of baptism, born in Adventist family or not)

Table 12. Logistic regression of vegetarian status on religious variables.

Variables	Bivariate			Multivariate [†]		
	B	SE	Odds ratio (CI)	B	SE	Odds ratio (CI)
Religious attendance						
Less than once per week						
Once a week	1.47	0.72	4.4(1.56,>13.96)*	1.56	0.75	4.5(1.32,>17.64)*
More than once per week	2.05	0.72	7.7(2.80,>26.81)**	2.80	0.75	7.0(2.29,>29.58)**
Private religious activities						
Less than once per week						
More than once per week	0.84	0.35	2.3(1.32,4.99)*	1.32	0.36	2.1(1.15,4.90)*
Intrinsic religiosity	0.34	0.11	1.4(1.15,1.92)*	1.15	0.12	1.5(1.21,1.97)***
Sabbath-keeping	0.28	0.06	1.3(1.18,1.58)***	1.18	0.07	1.3(1.20,1.63)***

Note. *p<0.05; **p<0.01; ***p<0.001

[†]Controlled for covariates (Age, gender, ethnicity, marital status, income, employment, education, age of baptism, born in Adventist family or not)

CHAPTER 6: SOCIAL GRADIENT AND DIET

6.1. Introduction

This chapter reports the finding of the statistical analysis on the relationship between social gradient and diet. It includes a published paper based on the results from multiple linear regression analyses of social gradient and dietary habits. The paper addressed the following research question: Does the social gradient remain in the dietary habits of the Seventh-Day Adventists in West Malaysia? It reported the results from the data of 574 participants.

6.1. Declaration for Thesis Chapter 6

Declaration by candidate

In the case of Chapter 2, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
<ul style="list-style-type: none">• Collected and analysed data• Wrote the draft• Designed the study	70

The following co-authors contributed to the work:

Name	Nature of contribution	Extent of contribution (%)
Daniel D. Reidpath	Provided advice in data collection and analysis and editorial input	15
Carina K. Y. Chan	Provided advice in data collection and analysis and editorial input	15

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work*.

Candidate's Signature	Date

Main Supervisor's Signature	Date

Does the social gradient remain in the dietary habits of a health-conscious population? A study of Seventh-Day Adventists in West Malaysia

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ABSTRACT

Background Socioeconomic status (SES) is a strong predictor of health, and individuals with higher SES generally have better health than those with lower SES. One of the pathways that SES influences health is through health behaviors, such as dietary intake, and a higher SES has been associated with a better diet. The purpose of this study was to determine whether there was a social gradient in dietary habits among the Seventh-Day Adventists, a group of conservative Christians, where healthy eating is part of the doctrinal teaching.

Methods Data from a survey of 574 Adventists residing in West Malaysia, aged 18–80 years, were analyzed. Dietary habits were measured using the Nutrition subscale of Health Promoting Lifestyle Profile II.

Results Education and income were significantly associated with dietary habits before and after controlling for demographics. There was a gradient of association; a higher level of education and higher income were associated with better dietary habits. However, only education remained significantly associated with dietary habits when the other two socioeconomic variables were included. Employment was not significantly associated with dietary habits before or after controlling for demographic variables and the other two sociodemographic variables.

Conclusions This study showed that education is the strongest predictor of healthy diet, and a social gradient in dietary habits still exists even among health-conscious population.

Keywords Adventists, diet, dietary habits, health behavior, socioeconomic status

Introduction

Socioeconomic status (SES) is a strong predictor of health, and individuals with higher SES tend to have better health than those with lower SES. This health inequality is found not just at the threshold of poverty but also at every level of the SES hierarchy.¹ The SES health gradient has been associated with many major diseases and conditions including cardiovascular diseases,² Type II diabetes,³ many cancers⁴ and arthritis.⁵

At the individual level, SES is usually measured by one or more of the three inter-related but not fully overlapping indicators: education, occupation and income.⁶ In earlier studies, SES was usually included as a control or confounding variable rather than the independent variable of direct interest.⁷ Over the past few decades, the impact of SES on health has become a direct focus of attention in health research.⁸

There is considerable evidence showing that SES is associated with health behaviors. People with lower SES are more likely to smoke,^{9,10} less likely to be physically active^{11,12} and more sedentary.¹³

SES appears to influence health indirectly through lack of access to health care, environmental exposure and effects on behavior and lifestyle, which contribute to ~80% of premature mortality; and among them, behavior and lifestyle account for about half of the premature mortality.^{14,15}

SES is also associated with dietary behaviors. Compared with those with high SES, individuals with low SES consume less fruits and vegetables,^{16–18} more added fat¹⁹ and less

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whole-grain food.²⁰ Unhealthy diet is a major contributor to the development of non-communicable diseases that are responsible for 63% or ~36 million deaths globally.^{21,22} The diet-related health disparities due to SES reflect not just differences in dietary intake and behaviors but also differences in the prevalence, mortality, morbidity and burden of diet-related diseases across social gradient.²³

The proposed causal relationship between SES and dietary quality raises an important question. Within a health-conscious community that pays specific attention to issues of healthy nutrition, does an SES gradient still exist? The Seventh-Day Adventists are a group of conservative Christians, for whom healthy eating is part of the doctrinal teaching of the Church. Increased consumption of plant-based food and vegetarianism is actively encouraged and potentially harmful activities such as recreational drug use, smoking and alcohol consumption are proscribed. A significant body of research has developed around Adventist's health behaviors and health outcomes.^{24,25} Compared with non-Adventists, Adventists enjoyed better health and had lower all-cause and cancer mortality rate,²⁶ and this has been attributed to their higher intake of fruits and vegetables and lower consumption of saturated fats than non-Adventists.^{27–33} Among Adventists, those who are more religious tend to have a better diet.³⁴

Generally, before being baptized into the Seventh-Day Adventist Church, a person will go through several months of doctrinal study that includes learning about the Adventists' teachings on health and diet. This is supported by various health-related activities conducted regularly within the Church, which reinforce the importance of maintaining a healthy body as part of one's devotion. The preference for the consumption of fruits and vegetables is further reinforced in this way, and through Church 'pot-luck' events. There is also some evidence to suggest that Adventists maintain their interest in the acquisition of health information.³⁵ It is unknown whether among the Adventists, SES also plays a role in their dietary quality despite their knowledge about healthy eating. Thus, the purpose of this study was to determine whether there was a social gradient in dietary habits among the Adventists.

Methods

Participants

Participants of this study were residents of West Malaysia who declared themselves to be baptized Seventh-Day Adventists, and older than 18 years. In 2013 when the study was conducted, the number of baptized Adventists at Peninsular Malaysia Mission (PMM), the Adventist

headquarters in West Malaysia, was 4380, including those who were younger than 18 years, and the total number of congregations was 49. Congregations ranged in size from 10 to 200 members. Out of the 4380 members, 2278 are active, i.e. attended church at least twice a month. The average total attendance on a given Saturday worship of all congregations in West Malaysia was ~1500, of whom ~50% were eligible participants for this study (the other 50% included children younger than 12 years, adolescents between 12–18 years, Adventists who were not residing in West Malaysia and non-Adventists). There was an estimated 1100 Adventists available for this study, including those who did not attend the Saturday worship when the questionnaires were administered.

Study design and procedure

This was a cross-sectional study based on questionnaire responses to items about socio-demographics and dietary habits. Ethics approval was obtained from the University's Human Research Ethics Committee, and permission to conduct the research was obtained from PMM.

Potential respondents of this study were recruited through the pastors of congregations across West Malaysia. Each congregation was approached by its own pastor, who announced the recruitment for at least 4 weeks prior to data collection. Interested participants were given a hard copy questionnaire by their pastors after worship service in the fifth week. The first author of this study is a baptized member of PMM. However, all direct communication with the potential participants and recruitment were done via the pastors. An online version of the questionnaire was also available. A link to the online questionnaire was sent to the participants who had indicated their interest and provided their contacts to their pastors and who were unable to attend the Saturday worship when the hard copy questionnaires were administered. The link was also posted on the Facebook page created for this study.

Measures

Socio-demographics

Information on age, sex, ethnicity, marital status, age of conversion/baptism and whether participants were born into an Adventist family was obtained. There were four categories of ethnicity: Chinese, Indians, non-Malay and non-Muslim Bumiputras (natives of Sabah and Sarawak states of Malaysia). Employment status was examined using five categories: employed, unemployed, retired, homemaker and student. For statistical analysis, the last three categories (retired, homemaker and student) were into the category

'other unemployed'. Monthly household income of the participants was categorized as <RM1000 (USD257), RM1001–2999 (USD257–771), RM3000–4999 (USD771–1285) and RM5000 (USD1285) and above. Highest education level of participants was categorized as secondary school or less, diploma (a higher education qualification just below a bachelor's degree) and bachelor's degree or above. Religious attendance was a single item that measured the frequency of participation in public religious activities. The response options were: (i) Never, (ii) Once a year or less, (iii) A few times a year, (iv) A few times a month, (v) Once a week, (vi) More than once per week. Due to low number of participants in the lower range of scores, religious attendance (organizational religiosity) was collapsed into three categories: less than once per week, once per week and more than once per week.

Dietary habits

Dietary habits were measured using the Nutrition subscale of Health Promoting Lifestyle Profile II (HPLPII). The HPLPII is a 48-item scale that measures six dimensions of wellness lifestyle: Self-Actualization, Health Responsibility, Exercise, Nutrition, Interpersonal Support and Stress Management (see Walker, Sechrist, and Pender³⁶ for the details of the development and psychometric properties of the scale). The Nutrition subscale contains nine items that assess various aspects of a healthy diet such as choosing a low-fat, low-salt and low-sugar diet, regular consumption of fruits and vegetables, eating breakfast, etc. The items are scored on a 4-point response scale (never, sometimes, often, routinely), and a higher score indicates a higher frequency. The total subscale score was obtained by calculating a mean of responses to the subscale items, ranging from 1 to 4. The internal consistency of the Nutrition Subscale is acceptable (Cronbach's $\alpha = 0.71$, in this study).

Analysis

Chi-square tests (for categorical variables) and *t*-tests (for continuous variables) were conducted to determine whether there were gender differences in socio-demographic variables and dietary habit.

Multistep hierarchical multiple regression analysis was conducted to analyze the relationship between socioeconomic variables and dietary habits. First, each socioeconomic variable (education, employment and income) was entered separately into the model to obtain the parameter coefficients for the bivariate relationship between the socioeconomic variable and dietary variable. Then, the socioeconomic variables were entered one at a time together with demographic variables (age, sex, ethnicity, marital status, age

of conversion/baptism and whether the participants were born into an Adventist family). In the last step, all three socioeconomic variables and demographic variables were entered together.

About 10% of the cases included some missing data. Multiple imputation was conducted to overcome this. It is a statistical technique to impute incomplete data and has been shown to reduce bias and increase efficiency compared to listwise deletion.³⁷ Unlike other procedures for handling missing data, multiple imputation does not assume that the data are completely missing at random.³⁸ Five imputed data sets were obtained, and each data set was analyzed separately and their results were pooled according to Rubin's rule.³⁹

Data were analyzed with R software.

Results

Six hundred and seven questionnaires were returned (500 hardcopies, 107 online questionnaires). Thirty-three questionnaires were excluded because the participants were younger than 18 years, age unclear or were Adventists not residing in West Malaysia, or non-Adventists. Five hundred seventy-four questionnaires (~77% of the 750 eligible Adventists of this study) from 45 Adventist congregations in West Malaysia were available for the analysis.

The average age of the study population was 34.6 years, while the average age of baptism (joining the Seventh-Day Adventist Church) was 19.4 years (Table 1). About half of the participants were Chinese, and a quarter was Bumiputra. About 44% of the participants were male and ~40% were currently married. About 45% of them were raised by parent(s) who are Seventh-Day Adventists. The study population were well-educated; about two-third of the individuals had completed at least a diploma. Sixty percent of them are currently employed. There were no significant socio-demographic differences between males and females, except occupation (there were significantly more female homemakers), and females had significantly better dietary habits than the males. About 90% of the participants attended religious services at least once a week. There was also no significant difference in religious attendance between males and females.

Regression of dietary habits on socioeconomic variables (education, employment and income) was conducted (Table 2). Employment was not significantly associated with dietary habits before and after controlling for demographic variables and the other two socio-demographic variables.

Education and income (RM3000–4999 and >RM5000) were significantly associated with dietary habits before and

Table 1 Socio-demographics

Variables	All	Males (n = 253)	Females (n = 321)
Demographics			
Age (years)	34.6 ± 13.70	35.31 ± 14.42	34.0 ± 13.09
Ethnicity			
Chinese	54.0%	51.5%	56.0%
Indian	9.4%	10.4%	8.6%
Indigenous	25.5%	24.0%	26.6%
Others	11.2%	14.2%	8.8%
Marital status			
Never married	52.4%	54.8%	50.6%
Currently married	41.4%	42.5%	40.6%
Previously married	6.1%	2.7%	8.8%
Age of baptism (years)	19.4 ± 10.08	19.6 ± 10.36	19.2 ± 8.86
Born in Adventist family (Yes)	45.7%	46.2%	45.3%
Religious attendance			
Less than once per week	10.4%	10.3%	10.4%
Once a week	48.6%	43.0%	53.1%
More than once per week	41.0%	46.7%	36.5%
SES			
Employment**			
Employed	60.0%	65.7%	55.6%
Unemployed	3.9%	3.8%	4.0%
Retired	2.8%	2.9%	2.6%
Homemakers	9.1%	0.5%	15.8%
Students	24.2%	27.1%	21.9%
Education			
Secondary school or less	37.1%	35.8%	38.1%
Diploma	25.7%	22.9%	28.0%
Bachelor's degree	37.1%	41.3%	33.9%
Graduate degree	7.1%	8.2%	6.3%
Monthly household income			
<RM1000	23.5%	23.6%	23.5%
RM1001–2999	35.6%	30.9%	39.4%
RM3000–4999	23.2%	22.6%	23.6%
≥RM5000	17.7%	22.9%	13.5%
Diet			
Dietary habit (1 = never, 4 = routinely)***	2.7 ± 0.48	2.7 ± 0.44	2.8 ± 0.50

Note: Significant differences by gender. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

after controlling for demographics. There is a gradient of association; a higher level of education and higher income were associated with better dietary habits. However, only education was still significantly associated with dietary habits when the other two socioeconomic variables were included.

Discussion

Main finding of this study

This study showed that even among the Adventists, where healthy eating is a perceived norm, there was a social gradient in dietary habits. The relationship between SES and dietary habits was the strongest and most consistent for education, where a higher level of education was positively and significantly associated with dietary habits before and after controlling for demographics and the other two SES indicators.

What is already known on this topic

The positive association between dietary habits and education was consistent with previous studies, which showed that education was associated with a better diet,⁴⁰ and only a higher level of education remained correlated with healthy dietary habits after controlling for other socioeconomic indicators.¹⁷ A study conducted in Japan also showed that education and not occupation and household income was positively associated with a better diet among pregnant women.⁴¹ In addition to diet, another study also found that education is also the strongest predictor of health risk factors such as cigarette smoking and hypertension and was the only significant predictor after adjusting for occupation and income.⁹

What this study adds

The Adventists generally have fairly good knowledge about healthy eating due to exposure to the topic during Bible study before joining the church and various health promotional activities within the church. The mean score of the Nutrition subscale of the HPLPII of the Adventists in this study was 2.7, which was higher compared with other populations such as Mexican Americans (mean score = 2.48)⁴² and young adults aged 18–35 years (mean score = 2.59).⁴³ We initially hypothesized that healthy eating is practiced homogeneously among the Adventists. However, in our study this was not the case; the more educated Adventists reported better diet than did the less educated participants.

The mechanisms of the positive association between education and healthy diet have not been fully explained. Some of the proposed mechanisms include increased problem-solving capacity and values and better acquisition of positive psychosocial and economic skills,^{9,44} better work and economic conditions, better socio-psychological resources in terms of social support and sense of control and healthier lifestyle⁴⁵ among the more educated. In our study, Adventists who were more educated might value healthy diet more and were more likely to follow the recommended dietary guidelines. They might also be more creative in

Table 2 Multiple linear regression of dietary habit on socioeconomic variables

Variables	Bivariate			Multivariate 1 ^a			Multivariate 2 ^b		
	β	SE	R ²	β	SE	R ²	β	SE	R ²
Education			0.023**			0.114***			0.130***
Secondary school or less									
Diploma ^c	0.109*	0.051		0.186*	0.052		0.225*	0.055	
Bachelor's and above	0.165***	0.046		0.204**	0.046		2.494*	0.211	
Employment			0.003			0.097***			
Employed									
Unemployed	-0.043	0.106		-0.107	0.143		-0.025	0.112	
Other unemployed	-0.027	0.043		0.014	0.044		1.072	0.286	
Income ^d			0.026**			0.118***			
<RM1000									
RM1001–RM2999	0.002	0.054		-0.075	0.060		-0.067	0.064	
RM3000–4999	0.122**	0.060		0.126	0.064		0.132	0.072	
≥RM5000	0.140**	0.063		0.163*	0.065		0.167	0.071	

^aOne socioeconomic variable at a time and controlled for demographics (gender, age, ethnicity, marital status, age of baptism, born in Adventist family and religious attendance).

^bAll socioeconomic variables and controlled for demographics (gender, age, ethnicity, marital status, age of baptism, born in Adventist family and religious attendance).

^cA higher education qualification just below a bachelor's degree.

^dIncome categories and their USD equivalent: <RM1000 = USD257, RM1001–2999 = USD257–771, RM3000–4999 = USD771–1285 and ≥RM5000 = ≥USD1285.

Note: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

finding ways to practice healthy eating because they have better knowledge of the resources of healthy food, for example health food stores/restaurants. They might feel more confident and empowered to practice healthy eating than the Adventists who were less educated.

Previous studies have shown that different SES indicators seem to have similar but independent effects on diet.¹⁵ People who are employed have better a diet than those who are not, and employment, together with education, have additive and synergistic effects on diet.⁴⁶ However, in this study, employment was not significantly associated with dietary habits. This may be due to the small number of unemployed participants in this study. Another reason could be that, compared with the unemployed, there were also many homemakers and students, who are unemployed but whose dietary habit might be affected by the employment of their spouse/parents. In this study, information about the employment status of the occupation of the participants' spouse or parents was not obtained, so there was no way to ascertain this relationship.

Some of the proposed causal mechanisms between low SES and poor dietary quality include higher costs of healthier food, poorer access to healthy food choice and poorer

nutritional knowledge.⁴⁷ Food price is one of the factors that influence whether a person is adopting a healthy diet; in many developed countries, people with less income are less likely to consume nutrient-dense food such as fruits and vegetables and whole grains, which are more costly.⁴⁷ In this study, higher monthly household income was associated with better dietary habits before and after controlling for demographics only but not after controlling for demographics, education and employment. After education and employment were taken into account, income did not predict dietary habits among the Adventists in West Malaysia, probably because the price of these foods in Malaysia is not as costly as that in developed countries.

The fact that higher income was not associated significantly with dietary habits after controlling for demographics, education and employment is consistent with the notion that occupation and education act as independent factors in predicting diet⁴⁶ and they should not be used interchangeably. These two indicators should not be used as proxy for each other since income may vary within similar education levels across different social groups and especially since the correlation between income and education in this study was 0.24 (not shown in Results), much lower than 0.50.⁸ When there

is financial and time constraint, it has been suggested that education is the best predictor to use in SES and health research rather than occupation and income.⁹ Compared with occupation and income, one advantage of using education as SES indicator is that it is the easiest to obtain and there is lower risk of missing data.⁴⁸ Speculatively, education might be a more profound influence of health behaviors than income. In cases where it is not possible to improve individual income and employment, education might provide an avenue for behavioral change.

Limitations of this study

Some limitations should be noted in this study. First, this study was based on self-reported SES and diet, which might have led to recall bias as well as social desirability bias. Second, even though there are official statistics about the membership of Adventists in West Malaysia, the record has not been updated regularly and the exact number of Adventists in West Malaysia is unknown.

Efforts have been made to recruit as many Adventists in West Malaysia as possible. However, those who refused to or did not participate might have different characteristics than those who participated. Third, due to the small sample size ($N = 574$), multivariate analyses were not performed by ethnicity and sex, two factors that also influence dietary practice together with SES.²³ Fourth, this study included a dietary scale rather than detailed records of dietary intake, such as food frequency questionnaire or 24-hour dietary recall. Fifth, the interaction between socioeconomic variables was not included in the analysis. While not strictly a limitation, it should be remembered that, Malays, the major ethnic group in Malaysia, which makes up ~60% of the population, were not included in the study. Malays are necessarily Muslim and not permitted to be Adventists. They have a different diet from the other ethnic groups in Malaysia, and the results are unlikely to generalize in any way to them.

Taking into considerations the limitations of this study, future research should use better dietary measures such as detailed records of dietary intake, and multivariate analyses by ethnicity and sex should be included. The strength of this study was the use of single denomination that removed the need to control for denominational differences.⁴⁹ Future studies should examine other populations with specific dietary guidelines, e.g. Muslims and Mormons. More insight could be gained by studying the interaction between socioeconomic variables.

This study showed that education is the strongest predictor of healthy diet, and a social gradient in dietary habits still exists even among the health-conscious population.

Given that many chronic diseases are strongly influenced by diet and also show disparities by SES, the study of SES and diet will help pave way to find methods to improve diet especially among those with lower SES, which carry the highest burden of chronic diseases.

Conflict of interest

None declared.

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CHAPTER 7: CONGREGATIONAL EFFECT AND DIET

Having established that individual religiosity is associated with individual dietary habits and vegetarian status and that social gradient exists in the dietary habits of Adventists, a health-conscious population, multilevel modelling is used to examine the question “Does congregational conservativeness predict individual diet over and above individual factors (religiosity and demographics)?”. This chapter includes the results of multilevel modelling of dietary habits and vegetarian status. There was no significant congregational clustering for fruit and vegetable intake, thus multilevel modelling would be redundant.

7.1. Results

7.1.1. Congregational Conservativeness

Pastors from forty-five congregations returned the questionnaires on congregational conservativeness. The average congregational conservativeness rating by pastors was 6.2 (1=most liberal, 10=most conservative), with a range of 2 to 10. Table 13 summarizes the number of participants from each of the 51 Adventist congregations in Malaysia.

Table 13. List of participating congregations and number of participants.

No	Church Name	Number of Participants
1	Alor Setar	2
2	Bagan Datoh Indian	0
3	Banting Indian	1
4	Bukit Jelutong Indian	2
5	Damansara Adventist Hope Centre	48
6	Farlim	1
7	Ipoh Chinese	19
8	Ipoh English	11
9	Johor Bahru BM	15
10	Johor Bahru English	7
11	Johor Bahru Indian	0
12	Klang BM	21
13	Klang Indian	1
14	Klebang Indian	2
15	Kluang	2
16	Kota Bahru Chinese	12
17	Kota Masai	7
18	Kuala Lumpur Chinese	27
19	Kuala Lumpur English	13
20	Kuala Selangor Indian	0
21	Kuantan Chinese	5
22	Kulai Chinese	17
23	Kulim	11
24	Kulim Indian	0
25	Lighthouse	34
26	Megah Ria	8
27	Melaka	16
28	Muar	4
29	Nibong Tebal Indian	0
30	Pandamaran BM	20
31	Penang Adventist Hopistal Church	4
32	Penang Chinese	20
33	Penang English	26
34	Penang Indian	0
35	Petaling Jaya Chinese	26
36	Petaling Jaya English	30
37	Pontian Chinese	14
38	Puchong Chinese	10
39	Puchong Indian	0
40	Seremban	1

41	Shah Alam Indian	2
42	Sitiawan Indian	0
43	Skudai Chinese	13
44	Sungai Petani	2
45	Sungai Way Indian	0
46	Taiping	0
47	Tampin	25
48	Teluk Indian Indian	12
49	Ulu Tiram	23
50	USJ	45
51	Utama Beacon	15

Ten congregations with zero participants were excluded from the multilevel analysis. Four of the congregations had only one participant; however, they were still included in the multilevel analysis because “they can still provide partial information that allows estimation of the coefficients and variance parameters of the individual- and group-level regressions” (Gelman & Hill, 2006, p. 275).

7.1.2. Multilevel Linear Regression

The null model is as follow:

$$D_{ij} = \gamma_{00} + u_{0j} + r_{ij}$$

where D_{ij} denotes the dietary variable (dietary habits and fruit and vegetable intake) for individual i nested in the congregation j , γ_{00} is the mean score of dietary variable in congregation j , u_{0j} is congregational-level error and r_{ij} is individual-level error.

For dietary habits, the estimated overall population mean dietary habits score, γ_{00} , was 2.74, with a standard error of .031. The estimated congregational-level variance was 0.017 and the estimated of individual-level variance was 0.21. Intra-class correlation (ICC) was computed using the following formula:

$$ICC = \frac{\sigma_{u_0}^2}{(\sigma_{u_0}^2 + \sigma_r^2)}$$

Where ICC is the intra-class correlation, $\sigma_{u_0}^2$ is the congregational-level variance, and σ_r^2 is the individual-level variance.

An ICC of 0.076 was obtained which means that 7.6% of the variance in individual dietary habits can be explained by congregational characteristics. There was a significant difference between the -2 log likelihood of the null model with the model without random intercept, indicating significant congregational-level variance. Thus, from the null model, there was a significant congregational-level variation in terms of dietary habits across the congregations, and about 7.6% of the variation in individuals' dietary habit score was due to the congregation to which he or she belongs.

For fruit and vegetable, the estimated overall population mean fruit and vegetable intake, γ_{00} , was 4.8 servings, with a standard error of 0.12. The estimated congregational-level variance was 0.15 and the estimated of individual-level variance was 5.24. An ICC of 0.028 was obtained which means that 2.8% of the variance in individual fruit and vegetable intake can be explained by congregational characteristics. There was a no significant difference between the -2 log likelihood of the null model with the model without random intercept; there was no significant congregational-level variation in terms of fruit and vegetable intake across the congregations. Thus, multilevel modelling would be redundant

Tables 14-17 summarize the three multilevel modelling results of individual and congregational variables on dietary habits for each religious variable. In Model 1, the relationship between dietary habit and demographics (age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether they are born into an Adventist family) was examined. Models 1 showed that age, being a female, having a Bachelor's degree and being born in an Adventist family were positively associated with dietary habits score, while age of baptism was negatively associated with dietary habits scores.

Models 2 built on model 1 and added individual religious variables. There was one model for each religious variable. In Models 2, only intrinsic religiosity and Sabbath keeping were positively and significantly associated with dietary habits.

Initially all congregational variables were added in Models 3. However, only congregational conservativeness was included in the final Models 3, since the other congregational variables had near zero regression coefficients. Congregational conservativeness was positively and significantly associated with dietary habits in all Models 3. The addition of congregational conservativeness in Models 3 improved the fit indexes over and above the addition of the individual religious variables in Models 2 in all four sets of models.

Table 14. Multilevel linear regression of dietary habits on demographics, religious attendance and congregational conservativeness.

Variables	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Fixed effect						
Intercept	2.51***	0.08	2.46***	0.09	2.17***	0.14
<i>individual level</i>						
Age	0.11***	0.03	0.11***	0.03	0.11***	0.03
Gender						
Male	Reference category					
Female	0.13***	0.04	0.14***	0.04	0.14***	0.04
Ethnicity						
Chinese	Reference category					
Indian	-0.10	0.08	-0.10	0.08	-0.09	0.07
Indigenous	0.08	0.06	0.08	0.06	0.13*	0.06
Others	-0.08	0.07	-0.08	0.07	-0.05	0.07
Marital status						
Unmarried	Reference category					
Currently married	-0.02	0.06	-0.02	0.06	-0.01	0.06
Previously married	0.06	0.09	0.05	0.09	0.07	0.09
Education						
Secondary school or less	Reference category					
Diploma	0.08	0.05	0.08	0.05	0.10	0.05
Bachelor's degree	0.10*	0.05	0.10	0.05	0.10	0.05
Graduate degree	0.11	0.08	0.10	0.08	0.10	0.08
Income [†]						
Less than RM1000	Reference category					
RM1001-2999	-0.04	0.06	-0.03	0.06	-0.02	0.06
RM3000-4999	0.06	0.06	0.07	0.06	0.08	0.06
Above RM5000	0.13	0.07	0.14*	0.07	0.15*	0.07
Employment (yes)	0.05	0.05	0.04	0.05	0.04	0.04
Age of baptism	-0.09***	0.02	-0.09***	0.02	-0.08***	0.03
Born in Adventist family						
No	Reference category					
Yes	0.09*	0.05	0.09	0.05	0.09	0.05
Religious attendance						
Less than once per week	Reference category					
Once a week			0.03	0.07	0.03	0.07
More than once per week			0.09	0.07	0.10	0.07
<i>Congregational level</i>						
Conservativeness					0.04**	0.01
Random effect						
	σ^2		σ^2		σ^2	
Congregation	0.013		0.013		0.008	

Residual	0.187	0.186	0.186
Fit indices			
AIC	729.5	730.10	726.20
-2 Log likelihood	691.5	688.10	680.20
Model Comparison			
	With Model 0	With Model 1	With Model 2
Chi-square (df)	72.2(16) ^{***}	3.4(2)	7.9(2) [*]
R²	With Model 0	With Model 0	With Model 0
Congregational level R ²	0.25	0.25	0.54
Individual level R ²	0.11	0.12	0.12

Note. *p<0.05; **p<0.01; ***p<0.001

σ^2 - variance; AIC - Akaike information criterion

†Income categories and their USD equivalent: Less than RM1000 =USD257, RM1001-2999=USD257-771, RM3000-4999=USD771-1285, and RM5000 and above=USD1285 and above

Table 15. Multilevel linear regression of dietary habits on demographics, private religious activities and congregational conservativeness.

Variables	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Fixed effect						
Intercept	2.51***	0.08	2.47***	0.08	2.20***	0.13
<i>individual level</i>						
Age	0.11***	0.03	0.11***	0.03	0.11***	0.03
Gender	Reference category					
Male	Reference category					
Female	0.13***	0.04	0.13***	0.04	0.13***	0.04
Ethnicity	Reference category					
Chinese	Reference category					
Indian	-0.10	0.08	-0.09	0.08	-0.08	0.07
Indigenous	0.08	0.06	0.08	0.06	0.12*	0.06
Others	-0.08	0.07	-0.08	0.07	-0.06	0.07
Marital status	Reference category					
Unmarried	Reference category					
Currently married	-0.02	0.06	-0.02	0.06	-0.01	0.06
Previously married	0.06	0.09	0.06	0.09	0.08	0.09
Education	Reference category					
Secondary school or less	Reference category					
Diploma	0.08	0.05	0.08	0.05	0.10	0.05
Bachelor's degree	0.10*	0.05	0.10*	0.05	0.11***	0.05
Graduate degree	0.11	0.08	0.10	0.08	0.11	0.08
Income [†]	Reference category					
Less than RM1000	Reference category					
RM1001-2999	-0.04	0.06	-0.04	0.06	-0.03	0.06
RM3000-4999	0.06	0.06	0.06	0.06	0.07	0.06
Above RM5000	0.13	0.07	0.12	0.07	0.14*	0.07
Employment (Yes)	0.05	0.05	0.05	0.05	0.05	0.05
Age of baptism	-0.09***	0.02	-0.09***	0.02	-0.09***	0.02
Born in Adventist family	Reference category					
No	Reference category					
Yes	0.09*	0.05	0.09*	0.05	0.09*	0.05
Private religious activities	Reference category					
Once or less than once per week	Reference category					
More than once per week			0.05	0.05	0.05	0.05
<i>Congregational level</i>						
Conservativeness					0.04**	0.01
Random effect						
	σ^2		σ^2		σ^2	
Congregation	0.013		0.012		0.008	

Residual	0.187	0.187	0.187
Fit indices			
AIC	729.5	730.00	726.80
-2 Log likelihood	691.5	690.00	682.80
Model Comparison			
	With Model 0	With Model 1	With Model 2
Chi-square (df)	72.2(16)***	1.5(2)	7.2(2)*
R²			
	With Model 0	With Model 0	With Model 0
Congregational level R ²	0.25	0.29	0.54
Individual level R ²	0.11	0.11	0.11

Note. *p<0.05; **p<0.01; ***p<0.001

σ^2 - variance; AIC - Akaike information criterion

†Income categories and their USD equivalent: Less than RM1000 =USD257, RM1001-2999=USD257-771, RM3000-4999=USD771-1285, and RM5000 and above=USD1285 and above

Table 16. Multilevel linear regression of dietary habits on demographics, intrinsic religiosity and congregational conservativeness.

Variables	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Intercept	2.51***	0.08	1.91***	0.20	1.65***	0.22
<i>individual level</i>						
Age	0.11***	0.03	0.10**	0.03	0.10**	0.03
Gender						
Male	Reference category					
Female	0.13***	0.04	0.13**	0.04	0.12**	0.04
Fixed effect						
Ethnicity						
Chinese	Reference category					
Indian	-0.10	0.08	-0.09	0.08	-0.08	0.07
Indigenous	0.08	0.06	0.06	0.06	0.10	0.06
Others	-0.08	0.07	-0.09	0.07	-0.06	0.07
Marital status						
Unmarried	Reference category					
Currently married	-0.02	0.06	-0.02	0.06	-0.01	0.06
Previously married	0.06	0.09	0.07	0.09	0.09	0.09
Education						
Secondary school or less	Reference category					
Diploma	0.08	0.05	0.08	0.05	0.10	0.05
Bachelor's degree	0.10*	0.05	0.10**	0.05	0.11*	0.05
Graduate degree	0.11	0.08	0.10	0.08	0.10	0.08
Income						
Less than RM1000	Reference category					
RM1001-2999	-0.04	0.06	-0.04	0.06	-0.03	0.06
RM3000-4999	0.06	0.06	0.07	0.06	0.07	0.06
Above RM5000	0.13	0.07	0.13	0.07	0.14*	0.07
Employment (Yes)	0.05	0.05	0.05	0.04	0.05	0.04
Age of baptism	-0.09***	0.02	-0.09***	0.02	-0.08***	0.02
Born in Adventist family						
No	Reference category					
Yes	0.09*	0.05	0.10**	0.05	0.10**	0.05
Intrinsic religiosity			0.04***	0.01	0.04***	0.01
<i>Congregational level</i>						
Conservativeness					0.04*	0.01
Random effect						
	σ^2		σ^2		σ^2	
Congregation	0.013		0.013		0.009	
Residual	0.187		0.183		0.183	

Fit indices

AIC	729.5	719.60	716.80
-2 Log likelihood	691.5	679.60	672.80
Model Comparison	With Model 0	With Model 1	With Model 2
Chi-square (df)	72.2(16) ^{***}	11.9(2) ^{**}	6.8(2) [*]
R²	With Model 0	With Model 0	With Model 0
Congregational level R ²	0.25	0.25	0.48
Individual level R ²	0.11	0.13	0.13

Note. *p<0.05; **p<0.01; ***p<0.001

σ² – variance; SD – standard deviation; AIC – Akaike information criterion

†Income categories and their USD equivalent: Less than RM1000 =USD257, RM1001-2999=USD257-771, RM3000-4999=USD771-1285, and RM5000 and above=USD1285 and above

Table 17. Multilevel linear regression of dietary habits on demographics, Sabbath-keeping and congregational conservativeness.

Variables	Model 1		Model 8		Model 9	
	β	SE	β	SE	β	SE
Fixed effect						
Intercept	2.51***	0.08	2.17***	0.13	1.94***	0.16
<i>individual level</i>						
Age	0.11***	0.03	0.10***	0.03	0.10***	0.03
Gender	Reference category					
Male	Reference category					
Female	0.13***	0.04	0.12***	0.04	0.12*	0.04
Ethnicity	Reference category					
Chinese	Reference category					
Indian	-0.10	0.08	-0.12	0.08	-0.11	0.07
Indigenous	0.08	0.06	0.08	0.06	0.12*	0.06
Others	-0.08	0.07	-0.07	0.07	-0.05	0.07
Marital status	Reference category					
Unmarried	Reference category					
Currently married	-0.02	0.06	-0.01	0.06	0.00	0.06
Previously married	0.06	0.09	0.07	0.09	0.08	0.09
Education	Reference category					
Secondary school or less	Reference category					
Diploma	0.08	0.05	0.10	0.05	0.11*	0.05
Bachelor's degree	0.10*	0.05	0.11*	0.05	0.11*	0.05
Graduate degree	0.11	0.08	0.10	0.08	0.10	0.08
Income	Reference category					
Less than RM1000	Reference category					
RM1001-2999	-0.04	0.06	-0.03	0.05	-0.02	0.05
RM3000-4999	0.06	0.06	0.07	0.06	0.08	0.06
Above RM5000	0.13	0.07	0.13*	0.07	0.14*	0.07
Employment (Yes)	0.05	0.05	0.04	0.05	0.04	0.04
Age of baptism	-0.09***	0.02	-0.08***	0.02	-0.08**	0.02
Born in Adventist family	Reference category					
No	Reference category					
Yes	0.09*	0.05	0.09*	0.05	0.09*	0.05
Sabbath-keeping			0.02**	0.01	0.02**	0.01
<i>Congregational level</i>						
Conservativeness					0.03*	0.01
Random effect						
	σ^2		σ^2		σ^2	
Congregation	0.013		0.011		0.007	
Residual	0.187		0.184		0.184	
Fit indices						
AIC	729.5		720.70		718.50	

-2 Log likelihood	691.5	680.70	674.50
Model Comparison	With Model 0	With Model 1	With Model 8
Chi-square (df)	72.2(16)***	10.8(2)**	6.2(2)*
R²	With Model 0	With Model 1	With Model 8
Congregational level R ²	0.25	0.36	0.60
Individual level R ²	0.11	0.13	0.13

Note. *p<0.05; **p<0.01; ***p<0.001

σ^2 - variance; AIC - Akaike information criterion

†Income categories and their USD equivalent: Less than RM1000 =USD257, RM1001-2999=USD257-771, RM3000-4999=USD771-1285, and RM5000 and above=USD1285 and above

7.1.3. Multilevel Logistic Regression

Multilevel logistic regression was used to examine how individual religiosity and congregational characteristics were associated with individual vegetarian status, a dichotomous variable. To determine how much of the variance individual vegetarian status, the intra-class correlation was calculated using the following formula:

$$ICC = \frac{\sigma_{u_0}^2}{(\sigma_{u_0}^2 + \pi^2/3)}$$

where ICC is the intra-class correlation, and $\sigma_{u_0}^2$ is the congregational-level variance.

About 28% of the variance in vegetarian status can be explained by congregational level. Tables 8-11 summarize the three multilevel modelling results of individual and congregational variables on vegetarian status for each religious variable. Model 1 includes individual level demographic variables only. It shows that being currently married and educational level were positively associated with vegetarian status in all four sets of models.

In Model 2, individual religious variables were added. Religious attendance, intrinsic religiosity and Sabbath-keeping were positively and significantly associated with vegetarian status. In Model 3, congregational conservativeness, was added. Congregational conservativeness was positively and significantly associated with vegetarian status in models that included religious attendance and private religious activities. However, the addition of congregational

conservativeness in Models 3 did not improve the fit indexes over and above the addition of the individual religious variables in Model 2 in all four sets of models.

Table 18. Multilevel logistic regression of vegetarian status on demographics, religious attendance and congregational conservativeness.

Variables	Model 1			Model 2			Model 3			
	<i>Fixed effect</i>	β	SE	OR(95% CI)	β	SE	OR(95% CI)	β	SE	OR(95% CI)
Intercept		-2.89	0.64	0.06(0.02, 0.20)***	-4.88	0.91	0.0076(0.0013, 0.045)***	-6.51	1.29	0.0015(0, 0.019)***
<i>individual level</i>										
Age		0.02	0.19	1.02(0.70, 1.48)	-0.05	0.20	0.95(0.65, 1.41)	-0.05	0.20	0.95(0.65, 1.40)
Gender										
Male				Reference category						
Female		-0.15	0.27	0.86(0.50, 1.46)	-0.05	0.28	0.95(0.55, 1.64)	-0.06	0.28	0.94(0.55, 1.62)
Ethnicity										
Chinese				Reference category						
Indian		0.06	0.53	1.06(0.37, 3.03)	-0.03	0.55	0.97(0.33, 2.88)	0.02	0.55	1.02(0.35, 2.98)
Indigenous		-0.81	0.49	0.44(0.17, 1.15)	-0.77	0.50	0.46(0.17, 1.24)	-0.58	0.50	0.56(0.21, 1.48)
Others		0.58	0.45	1.79(0.74, 4.35)	0.55	0.47	1.74(0.69, 4.35)	0.64	0.47	1.90(0.76, 4.75)
Marital status										
Unmarried				Reference category						
Currently married		0.84	0.42	2.31(1.01, 5.28)*	0.89	0.44	2.44(1.03, 5.75)*	0.89	0.44	2.44(1.04, 5.76)*
Previously married		0.85	0.64	2.33(0.66, 8.24)	0.87	0.65	2.39(0.67, 8.55)	0.91	0.65	2.49(0.70, 8.89)
Education		0.38	0.15	1.46(1.09, 1.96)**	0.35	0.15	1.41(1.05, 1.90)*	0.35	0.15	1.41(1.05, 1.90)*
Income		-0.21	0.16	0.81(0.60, 1.11)	-0.19	0.16	0.83(0.60, 1.14)	-0.18	0.16	0.84(0.60, 1.15)
Occupation										
Employed				Reference category						
Unemployed		0.29	0.30	1.33(0.75, 2.39)	0.20	0.31	1.22(0.67, 2.23)	0.20	0.30	1.22(0.67, 2.22)
Age of baptism		-0.21	0.16	0.81(0.59, 1.11)	-0.15	0.16	0.86(0.63, 1.19)	-0.12	0.16	0.89(0.64, 1.22)

Born in Adventist family										
No	Reference category									
Yes	0.56	0.32	1.75(0.93, 3.30)	0.50	0.33	1.66(0.87, 3.16)	0.50	0.33	1.65(0.86, 3.16)	
Religious attendance				0.83	0.24	2.29(1.43,3.68)***	0.83	0.24	2.30(1.44, 3.69)***	
<i>Congregational level</i>										
Conservativeness							0.26	0.12	1.30(1.02, 1.66)*	
Random effect			σ^2			σ^2			σ^2	
Congregation			1.23			1.39			1.05	
Fit indices										
AIC			484.4			473.0			474.8	
-2 Log likelihood			456.4			442.7			438.8	
Model Comparison										
			With Model 0			With Model 1			With Model 2	
Chi-square(df)			25.9(12)*			13.7(1)***			3.9(2)	

Note. *p<0.05; **p<0.01; ***p<0.001

σ^2 – variance; AIC – Akaike information criterion

Table 19. Multilevel logistic regression of vegetarian status on demographics, private religious activities and congregational conservativeness.

Variables	Model 1			Model 2			Model 3		
	β	SE	OR(95% CI)	β	SE	OR(95% CI)	β	SE	OR(95% CI)
Fixed effect									
Intercept	-2.89	0.64	0.06(0.02, 0.20)***	-3.79	0.93	0.023(0.0037, 0.14)***	-5.19	1.23	0.0056(0, 0.062)
<i>individual level</i>									
Age	0.02	0.19	1.02(0.70, 1.48)	0.00	0.19	1.00(0.68, 1.45)	0.00	0.19	1.00(0.69, 1.45)
Gender									
Male	Reference category								
Female	-0.15	0.27	0.86(0.50, 1.46)	-0.14	0.27	0.87(0.51, 1.49)	-0.15	0.27	0.86(0.51, 1.47)***
Ethnicity									
Chinese	Reference category								
Indian	0.06	0.53	1.06(0.37, 3.03)	0.05	0.54	1.05(0.37, 2.99)	0.10	0.53	1.10(0.39, 3.13)
Indigenous	-0.81	0.49	0.44(0.17, 1.15)	-0.81	0.49	0.44(0.17, 1.16)	-0.63	0.49	0.53(0.20, 1.40)
Others	0.58	0.45	1.79(0.74, 4.35)	0.53	0.46	1.70(0.70, 4.15)	0.63	0.46	1.87(0.77, 4.58)
Marital status									
Unmarried	Reference category								
Currently married	0.84	0.42	2.31(1.01, 5.28)*	0.85	0.42	2.33(1.02, 5.35)*	0.85	0.42	2.35(1.03, 5.37)*
Previously married	0.85	0.64	2.33(0.66, 8.24)	0.85	0.65	2.35(0.66, 8.34)	0.90	0.64	2.45(0.69, 8.68)
Education	0.38	0.15	1.46(1.09, 1.96)**	0.36	0.15	1.43(1.07, 1.92)*	0.37	0.15	1.44(1.07, 1.93)*
Income	-0.21	0.16	0.81(0.60, 1.11)	-0.22	0.16	0.80(0.59, 1.09)	-0.21	0.16	0.81(0.70, 1.10)
Occupation									
Employed	Reference category								
Unemployed	0.29	0.30	1.33(0.75, 2.39)	0.26	0.30	1.29(0.72, 2.32)	0.26	0.30	1.29(0.72, 2.31)
Age of baptism	-0.21	0.16	0.81(0.59, 1.11)	-0.20	0.16	0.82(0.60, 1.12)	-0.17	0.16	0.84(0.61, 1.15)

Born in Adventist family										
No	Reference category									
Yes	0.56	0.32	1.75(0.93, 3.30)	0.57	0.33	1.77(0.93, 3.35)	0.57	0.33	1.76(0.93, 3.35)	
Private religious activities				0.55	0.38	1.73(0.82, 3.66)	0.53	0.38	1.69(0.80, 3.57)	
<i>Congregational level</i>										
Conservativeness							0.24	0.12	1.27(1.00, 1.59)*	
Random effect		σ^2			σ^2				σ^2	
Congregation		1.16			1.16				0.90	
Fit indices										
AIC		484.4			484.0				484.2	
-2 Log likelihood		456.4			454.0				450.2	
Model Comparison										
		With Model 0			With Model 1			With Model 2		
Chi-square(df)		25.9(12)*			2.5(1)			3.8(2)		

Note. *p<0.05; **p<0.01; ***p<0.001

σ^2 – variance; AIC – Akaike information criterion

Table 20. Multilevel logistic regression of vegetarian status on demographics, intrinsic religiosity and congregational conservativeness.

Variables	Model 1			Model 2			Model 3		
	β	SE	OR(95% CI)	β	SE	OR(95% CI)	β	SE	OR(95% CI)
Fixed effect									
Intercept	-2.89	0.64	0.06(0.02, 0.20)***	-7.69	1.91	0.00046(0, 0.019)***	-9.05	2.07	0.00012(0, 0.0069)***
<i>individual level</i>									
Age	0.02	0.19	1.02(0.70, 1.48)	-0.07	0.19	0.93(0.64, 1.36)	-0.07	0.19	0.93(0.64, 1.36)
Gender									
Male	Reference category								
Female	-0.15	0.27	0.86(0.50, 1.46)	-0.15	0.27	0.86(0.51, 1.47)	-0.16	0.27	0.85(0.50, 1.46)
Ethnicity									
Chinese	Reference category								
Indian	0.06	0.53	1.06(0.37, 3.03)	0.10	0.54	1.10(0.38, 3.18)	0.14	0.54	1.15(0.40, 3.28)
Indigenous	-0.81	0.49	0.44(0.17, 1.15)	-0.94	0.49	0.39(0.15, 1.03)	-0.75	0.49	0.47(0.18, 1.24)
Others	0.58	0.45	1.79(0.74, 4.35)	0.56	0.46	1.75(0.72, 4.28)	0.65	0.46	1.92(0.79, 4.70)
Marital status									
Unmarried	Reference category								
Currently married	0.84	0.42	2.31(1.01, 5.28)*	0.79	0.42	2.21(0.97, 5.03)*	0.80	0.42	2.22(0.98, 5.06)*
Previously married	0.85	0.64	2.33(0.66, 8.24)	0.87	0.65	2.38(0.66, 8.57)	0.90	0.66	2.46(0.68, 8.89)
Education	0.38	0.15	1.46(1.09, 1.96)**	0.37	0.15	1.45(1.07, 1.95)*	0.37	0.15	1.45(1.07, 1.95)*
Income	-0.21	0.16	0.81(0.60, 1.11)	-0.21	0.16	0.81(0.60, 1.11)	-0.20	0.16	0.82(0.60, 1.12)
Occupation									
Employed	Reference category								
Unemployed	0.29	0.30	1.33(0.75, 2.39)	0.26	0.30	1.29(0.72, 2.32)	0.26	0.30	1.30(0.72, 2.32)
Age of baptism	-0.21	0.16	0.81(0.59, 1.11)	-0.20	0.16	0.82(0.59, 1.12)	-0.17	0.16	0.84(0.61, 1.16)

Born in Adventist family										
No	Reference category									
Yes	0.56	0.32	1.75(0.93, 3.30)	0.62	0.33	1.85(0.96, 3.57)	0.61	0.34	1.85(0.95, 3.58)	
Intrinsic religiosity				0.34	0.13	1.41(1.10, 1.80)**	0.33	0.12	1.39(1.09, 1.78)**	
<i>Congregational level</i>										
Conservativeness							0.23	0.12	1.26(0.99, 1.59)	
Random effect		σ^2			σ^2				Var	
Congregation		1.23			1.19				0.95	
Fit indices										
AIC		484.4			475.9				476.4	
-2 Log likelihood		456.4			445.9				442.4	
Model Comparison		With Model 0			With Model 1			With Model 2		
Chi-square(df)		25.9(12)*			10.5(1)**			3.5(2)		

Note. *p<0.05; **p<0.01; ***p<0.001

σ^2 – variance; AIC – Akaike information criterion

Table 21. Multilevel logistic regression of vegetarian status on demographics, Sabbath-keeping and congregational conservativeness.

Variables	Model 1			Model 2			Model 3			
	<i>Fixed effect</i>	β	SE	OR(95% CI)	β	SE	OR(95% CI)	β	SE	OR(95% CI)
Intercept		-2.89	0.64	0.06(0.02, 0.20)***	-8.09	1.71	0.00031(0, 0.0086)***	-9.19	1.85	0.00010(0, 0.0039)***
<i>individual level</i>										
Age		0.02	0.19	1.02(0.70, 1.48)	-0.12	0.19	0.89(0.61, 1.30)	-0.11	0.19	0.89(0.61, 1.30)
Gender										
Male				Reference category						
Female		-0.15	0.27	0.86(0.50, 1.46)	-0.26	0.28	0.77(0.45, 1.33)	-0.27	0.28	0.76(0.44, 1.31)
Ethnicity										
Chinese				Reference category						
Indian		0.06	0.53	1.06(0.37, 3.03)	-0.23	0.55	0.79(0.27, 2.30)	-0.20	0.54	0.82(0.28, 2.36)
Indigenous		-0.81	0.49	0.44(0.17, 1.15)	-0.74	0.48	0.48(0.18, 1.23)	-0.59	0.49	0.56(0.21, 1.44)
Others		0.58	0.45	1.79(0.74, 4.35)	0.67	0.45	1.96(0.80, 4.76)	0.74	0.45	2.09(0.86, 5.09)***
Marital status										
Unmarried				Reference category						
Currently married		0.84	0.42	2.31(1.01, 5.28)*	0.84	0.43	2.31(1.01, 5.32)	0.84	0.43	2.31(1.00, 5.31)*
Previously married		0.85	0.64	2.33(0.66, 8.24)	0.87	0.65	2.38(0.67, 8.51)	0.90	0.65	2.46(0.69, 8.73)
Education		0.38	0.15	1.46(1.09, 1.96)**	0.36	0.15	1.43(1.07, 1.91)*	0.36	0.15	1.43(1.07, 1.92)*
Income		-0.21	0.16	0.81(0.60, 1.11)	-0.22	0.16	0.81*0.59, 1.09)	-0.21	0.16	0.81(0.60, 1.10)
Occupation										
Employed				Reference category						
Unemployed		0.29	0.30	1.33(0.75, 2.39)	0.10	0.30	1.11*0.62, 2.00)	0.11	0.30	1.12(0.62, 2.01)
Age of baptism		-0.21	0.16	0.81(0.59, 1.11)	-0.12	0.17	0.89(0.64, 1.23)	-0.09	0.17	0.91(0.66, 1.26)

Born in Adventist family									
No	Reference category								
Yes	0.56	0.32	1.75(0.93, 3.30)	0.55	0.33	1.74(0.91, 3.34)	0.54	0.33	1.72(0.89, 3.32)
Sabbath-keeping				0.25	0.07	1.29(1.12, 1.49)***	0.25	0.07	1.28(1.11, 1.48)***
<i>Congregational level</i>									
Conservativeness							0.20	0.11	1.22(0.97, 1.53)
Random effect			σ^2			σ^2			σ^2
Congregation			1.23			1.00			0.80
Fit indices									
AIC			484.4			464.8			465.9
-2 Log likelihood			456.4			434.8			431.9
Model Comparison			With Model 0			With Model 1			With Model 2
Chi-square(df)			25.9(12)*			21.7(1)***			2.8(2)

*p<0.05; **p<0.01; ***p<0.001

σ^2 – variance; AIC – Akaike information criterion

7.2. Discussions

7.2.1. Dietary Habits

There has been considerable research showing the effects of neighbourhoods on health (Cummins et al., 2005; Parkes & Kearns, 2006; Stafford & Marmot, 2003), and a small amount of research looking at religious congregations as “neighbourhoods” that affect social values (Houston & Todd, 2013; Todd & Allen, 2011). There has been, however, no research looking at the effect of congregations on health outcomes. The current study showed that congregational conservativeness was significantly associated with individual dietary habits above and beyond any association with individual characteristics.

At the individual level, the current study showed that age, sex (being female), level of education, and greater personal religiosity were all positively associated with better dietary habit score. This was consistent with previous studies which showed that females have healthier food choice than males (Baker & Wardle, 2003; Wardle et al., 2004). Older females also consumed more fruit and vegetable (Liu et al., 2000). People who were more educated also had healthier diet (Johansson et al., 1999; Murakami et al., 2009; Shimakawa et al., 1994). A higher level of religiosity is associated with regular breakfast (Wallace & Forman, 1998) and lower soft drinks consumption (Pitel et al., 2012) among adolescents, healthful nutrition (Chliaoutakis et al., 2002; Homan, 2010; Reid & Smalls, 2004), healthy food choices and eating patterns (Rew et al., 2007).

At the congregational level, greater congregational conservativeness was positively associated with better individual dietary habit scores. Given the data, we can only speculate about the nature of the relationship between congregational conservativeness and individual dietary habit. One possible reason that an individual attending a more conservative church is more likely to practice healthy eating than an equivalent individual attending a less conservative church relates to the intensity of exposure to health related messages. Given the doctrinal centrality of health and diet to SDA teachings, more conservative church might have more health-related sermons and seminars, and more health literature being distributed, and displayed within the church. This would be consistent with one recent study which found that higher perceived church support for healthy eating through spoken and written information within the church was positively associated with higher fruit and vegetable intake and low-fat dietary consumption (Baruth et al., 2011). What is clear, however, is that there is an effect above and beyond the individual congregants' religiosity.

The conservativeness of a congregation, one might imagine, would be influenced by the conservativeness of the faith leader of the congregation. Presuming doctrinally more conservative SDA pastors are more likely to adhere to the central teaching around healthy diet and healthy behaviour this could also influence the entire congregation. This would be consistent with a study by Bopp & Fallon (2011), when they found that congregations with faith leaders' who were more physically active and consumed more fruit and vegetables also tended to engage in more health and wellness activities (Bopp & Fallon, 2011).

In addition, there may be effects of social conformity on dietary choices (Mollen et al., 2013). Aggregating individual choices may create a norm within the congregation towards more or less healthy diets. Within doctrinally conservative congregations this would have the effect of creating a social support structure to practice healthy eating. Religion also predicts conformity for a number of social norms (Welch et al., 2006), and the less adherent individual attending a more conservative congregation might feel the social pressure to conform to the diet of other members of the congregation. In addition, a more conservative congregation might be more explicit regarding its doctrinal teaching about diet and thus providing clear guidelines for the congregation to follow. One study, for instance, found that a higher cohesion within a congregation resulted in more formal and more explicit rules are positively associated with higher fruit and vegetable intake and lower fat intake (Hart et al., 2007).

7.2.2. Fruit and Vegetable Intake

For fruit and vegetable intake, there was no significant congregational clustering. As discussed in the paper in Chapter 5, the reason for the non-significant effect could be that the teaching of fruit and vegetable is so common among the Adventist churches that congregational characteristics have no influence on this variable. Adventist churches generally emphasize high intake of fruit and vegetable, as evidenced by studies which showed that Adventists tend to consume more fruit and vegetable compared with the other Christians and the general population (Rouse et al., 1983). The results from Chapter 4 also show that the

mean fruit and vegetable consumption of the Adventists in West Malaysia was substantially higher than the Malaysian average.

7.2.3. Vegetarian Status

It is interesting to note that while conservativeness is a significant predictor of vegetarian status in models that included religious attendance and private religious activities, the models themselves (Models 3) were not significantly better than the models not containing level-2 explanatory variables. An immediate response may simply be to discard the variable because its addition did not add to the fit, nonetheless, it is worth retaining, at the very least as a reminder to future researchers that this effect may need further consideration. About 28% of the variance in vegetarian status can be explained by congregational level; rather than congregational conservativeness, there might be other congregational characteristics that play a role in vegetarian status and were not accounted for in this study. Future research should consider other congregational variables.

CHAPTER 8: HEALTH BEHAVIOURS AS MEDIATORS

Having established that individual religiosity is positively associated with dietary habits and vegetarian status and that congregational conservativeness predicts individual dietary habits above and beyond individual religiosity, it is possible that health behaviours may mediate the relationship between religiosity and health outcomes. Thus, this chapter examines the research question “Do alcohol consumption, dietary habits and exercise mediate the relationship between individual religiosity and health outcomes among the Seventh-day Adventist in West Malaysia?” To answer this research question, path analysis was conducted to determine whether health behaviours (alcohol consumption, dietary habit and exercise) mediate the relationship between individual religiosity (religious attendance, private religious activities, intrinsic religiosity, and Sabbath-keeping) and health outcomes (systolic and diastolic blood pressure, blood glucose level, body mass index and waist circumference). The first section presents a summary of the health screening results and results of path analysis. The second section discusses the results of the path analysis.

7.1. Results

One hundred people participated in the health screening, where their height, weight, blood pressure, blood glucose level, and waist and hip circumferences were measured. The mean age of the participants was 34.6 years. None of the participants were taking medication for hypertension and diabetes. Table 10 summarised the results of the health screening. T-tests were conducted to determine whether there was gender difference in blood pressure and blood

glucose level. Males had significantly higher systolic blood pressure and blood glucose level than the females. Two of the participants had systolic blood pressure higher than 120 and diastolic blood pressure higher than 90. None of the participants had blood glucose level more than 11mmol/l, which is the cut-off point for hyperglycaemia (American Diabetes Association, 2006).

Table 22. Summary of health screening results (N=100).

Variables	All	Male (n=54)	Female (n=46)
Height (m)	1.6±9.08	1.7±6.65	1.6±6.35
Weight (kg)	70.0±6.31	81.2±8.39	56.0±11.48
BMI (kg/m ²)	23.8±4.30	24.6±4.16	23.0±4.36
Underweight (BMI<18.5)	11.0%	7.4%	15.2%
Normal (BMI=18.5-22.9)	43.0%	27.8%	41.3%
Overweight (BMI>23)			
Pre-Obese (BMI=23-27.5)	31.0%	50.0%	26.1%
Obese (BMI>27.5)	15.0%	14.8%	17.4%
Systolic blood pressure (mmHg) ^{***}	121.0±13.89	126.3±12.44	114.8±12.98
Diastolic blood pressure (mmHg)	72.4±8.82	72.8±7.4	71.9±10.3
Blood glucose level (mmol/l) ^{***}	7.7±9.51	6.7±1.32	8.8±13.94
Waist circumference (cm)	82.0±11.99	87.1±9.27	75.7±12.0
Abdominal obesity	33.0%	33.3%	32.6%
Hip circumference (cm)	93.9±9.48	93.4±9.15	94.5±9.94
Waist-to-hip ratio	0.87±0.097	0.93±0.065	0.90±0.076

Note. Significant differences by gender: ^{***}p<0.001

Males had significantly lower self-reported hip circumference than the females. However, there was no significant difference by gender in hip circumference. Overall, the prevalence of abdominal obesity calculated from the measured waist circumference (overall=33.0%, males=33.3%, females=32.6%, Table 22) was higher

compared to that calculated from self-reported waist circumference (overall=23.2%, males=15.9%, females=29.0%). The difference was two-fold in the abdominal obesity among males. Similarly, the prevalence of pre-obesity among males calculated from measured height and weight (50.0%) was about one-third higher than that calculated from self-reported height and weight (34.8%). This might be due to the fact that males under reported their waist circumference (mean self-reported waist circumference=80.3cm, mean measured waist circumference=87.1cm) and weight. The abdominal obesity from measured waist circumference among males was comparable to the Malaysian population (38.2%). The overall abdominal obesity and female abdominal obesity were still lower than the Malaysian population (overall=48.6%, females=60.2%).

Pearson product-moment coefficients were calculated for correlations between religious, health behaviour (except alcohol consumption in the past 30 days) and health outcomes variables. Alcohol consumption in the past 30 days is a dichotomous variable and point-biserial correlation coefficients were calculated for correlation between alcohol consumption and other variables. The correlational analysis showed that religious variables were not significantly correlated with any of the health behaviours and health outcomes, except private religious activities and alcohol consumption in the past 30 days, which were negatively correlated; while systolic and diastolic blood pressures, and blood glucose level were positively correlated with waist circumference (see Table 22). Systolic blood pressure was positively correlated with diastolic blood pressure and body mass index (see Table 22).

Table 23. Correlations among religious, health behavioural, and health outcome variables.

	RA	PRA	IR	Alco [†]	DH	Ex	SBP	DBP	Glu	BMI	Waist
RA	1.00	0.26*	0.06	-0.15	0.03	0.00	-0.17	-0.11	-0.03	0.14	0.10
PRA		1.00	0.30**	-0.32*	0.03	0.13	0.06	0.06	0.04	-0.01	0.08
IR			1.00	-0.32	0.08	-0.05	-0.09	-0.12	0.08	-0.18	-0.16
Alco [†]				1.00	-0.15	0.12	0.0053	0.032	-0.070	0.25	0.17
DH					1.00	0.07	0.02	0.17	-0.05	-0.14	-0.17
Exe						1.00	0.06	-0.11	-0.13	-0.06	-0.14
SBP							1.00	0.53***	0.11	0.22*	0.42***
DBP								1.00	0.07	0.14	0.21*
Glu									1.00	0.14	0.21*
BMI										1.00	0.78
Waist											1.00

[†] Point-biserial correlation. The others are Pearson correlations.

RA=religious attendance; PRA=private religious activities; IR=intrinsic religiosity; Alco=alcohol consumption in the past 30 days; DH=dietary habits; Ex=exercise; SBP=systolic blood pressure; DBP=diastolic blood pressure; Glu=blood glucose level; BMI=body mass index; Waist=waist circumference

*p<0.05; **p<0.01; ***p<0.001

Twenty path analyses were conducted for this study. None of the health behaviours significantly mediated the relationship between religiosity and health outcomes, except alcohol consumption on Sabbath-keeping and blood glucose level (Figure 5), and alcohol consumption on Sabbath-keeping and body mass index (Figure 6), and diet on Sabbath-keeping and body mass index. Sabbath-keeping was negatively associated with alcohol consumption in both path analyses, which in turn was negatively associated with blood glucose level and positively associated with BMI. The other eighteen path diagrams are available in [Appendix N](#).

Figure 5. Effects of Sabbath-keeping on blood glucose level.

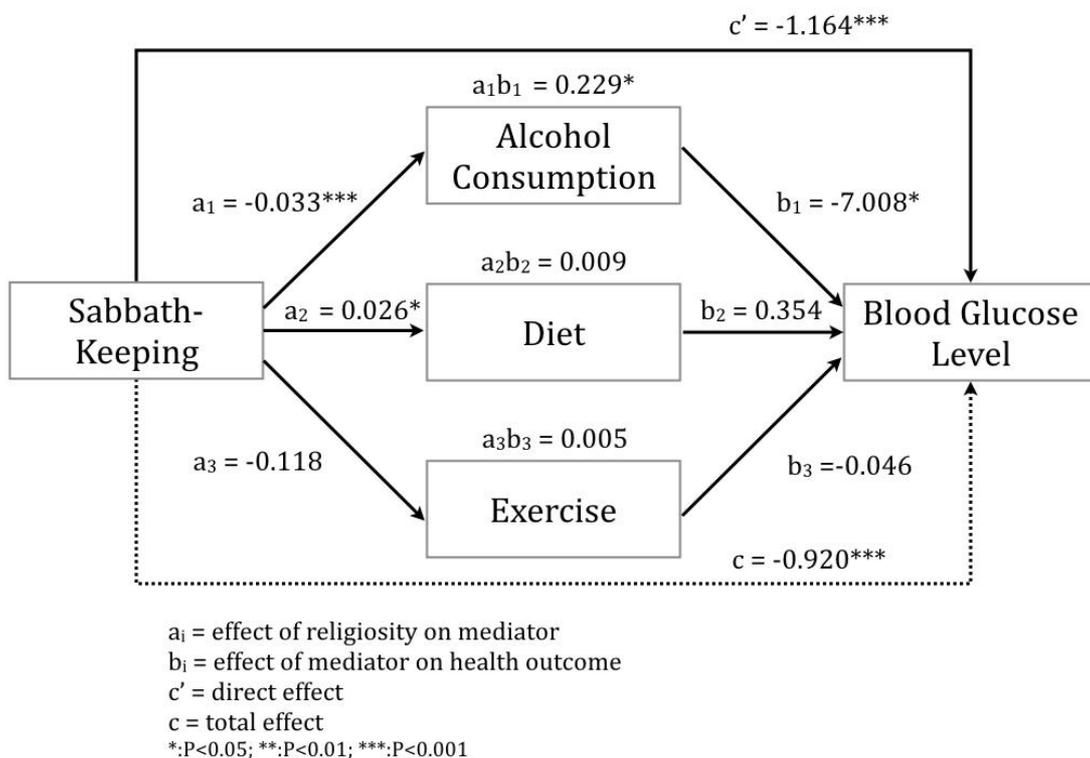
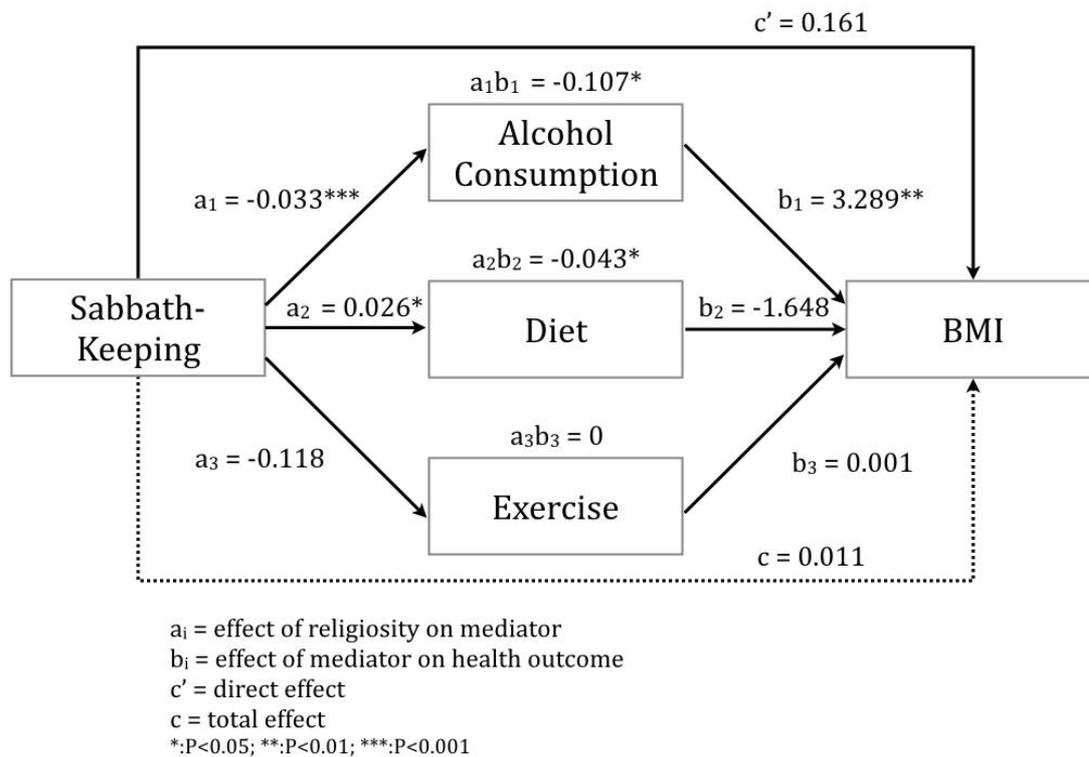


Figure 6. Effects of Sabbath-keeping on body mass index.



Tables 24 and 25 summarises the indirect, direct and total effects of the four religious variables on systolic blood pressure, diastolic blood pressure, blood glucose level, body mass index and waist circumference as determined by the 20 path analyses. Indirect effect is the sum of all the indirect effects of religiosity and health outcome through the mediators. None of the indirect effects were significant. Overall, the direct effects on systolic and diastolic blood pressure, blood glucose level, body mass index and waist circumference were larger than the indirect effects.

Table 24. Summary of indirect, direct and total effects of religiosity on systolic blood pressure and diastolic blood pressure.

Religious variables	Effects on SBP			Effects on DBP		
	Indirect	Direct	Total	Indirect	Direct	Total
Religious attendance	0.10	-6.10**	-6.00**	0.12	-0.44	-0.32
Private religious activities	0.40	-1.63	-1.24	-2.00	5.91***	3.92
Intrinsic religiosity	-0.02	-0.88	-0.90	-0.08	-0.51	-0.59
Sabbath-keeping	0.12	-0.44	-0.32	0.023	-0.47*	-0.45*

*p<0.05; **p<0.01; ***p<0.001

Table 25. Summary of indirect, direct and total effects of religiosity on blood glucose level, body mass index and waist circumference.

Religious variables	Effects on BGL			Effects on BMI			Effects on WC		
	Indirect	Direct	Total	Indirect	Direct	Total	Indirect	Direct	Total
Religious attendance	0.10	-0.82	-0.72	-0.18	0.67	0.49	-0.24	0.95	0.71
Private religious activities	0.18	0.34	0.52	-0.90	0.40	-0.50	-1.73	3.32	1.59
Intrinsic religiosity	0.14	0.27	0.41	-0.13	-0.41	-0.54	-0.16	-0.62	-0.78
Sabbath-keeping	0.24	-1.16***	-0.92***	-0.15	0.16	0.01	-0.20	0.002	-0.20

***p<0.001

For systolic blood pressure, all the total effects were negative. Religious attendance had the strongest negative total effect (unstandardized point estimate=-6.00) on systolic blood pressure compared with the other three religious variables and was the only one significant. For diastolic blood pressure, all the total and direct effects of religious variables were negative, except private religious activities, which also had the strongest significant and positive direct effect (unstandardized point estimate=5.91). However, the total effect of private religious activities was not significant. Sabbath-keeping had small but significant negative direct and total effects on diastolic blood pressure and blood glucose level. None of the religious variables had significant direct and total effects on body mass index and waist circumference.

7.2. Discussions

The results of the path analyses showed that alcohol consumption, dietary habits and exercise did not mediate the relationship between individual religiosity and blood pressure, blood glucose level, body mass index and waist circumference, and overall the direct effects of religiosity on the health outcomes were stronger than the indirect effects through health behaviours. In other words, instead of acting through health behaviours, religiosity directly influences health outcomes. The results also showed that different dimensions of religiosity influence health outcomes differently.

A few previous studies have shown similar direct influence of religiosity on health instead of through mediators such as health-promoting behaviours. For example, in a study that investigated the relationship between religiosity and blood pressure among men, while there was no difference in blood pressure between non-smokers of high and low religious importance groups, smokers who consider religion important in their lives had significantly lower systolic and diastolic blood pressure compared with smokers who consider religion unimportant, before and after adjusting for covariates (Meihan & Chung-Ngok, 2011).

In the current study, religious attendance had significant and strong total effects (-6.00) on systolic blood pressure; i.e. the higher the attendance, the lower the systolic blood pressure. This is consistent with previous studies on religious attendance and blood pressure (Can et al., 2008; Gillum & Ingram, 2006; Levin & Vanderpool, 1989). One of the causes of hypertension is stress (Kuster & Fong, 1993). Attending religious functions regularly enables positive religious coping and the social support a congregant receives could help to reduce stress, which in turn reduces blood pressure (Walker et al., 1987). In a study that examined composite religiosity score, a higher religiosity is associated with lower salivary cortisol, which is an objective indicator of lower stress responses to stressful task (Peltzer et al., 2013).

A study of Adventists in North American found that the relationship between Sabbath-keeping and self-reported physical and mental health was mediated by health behaviours (exercise and diet) (Supervill et al., 2013). However, in this

study, health behaviours did not mediate the relationship between Sabbath-keeping and diastolic blood pressure and blood glucose level. It is unknown why the results are different even though in both studies the samples were Adventists. It could be that the North American study examined general physical and mental health while in the current study specific health outcomes were measured. In addition, the North American study is extensive and included more than 90,000 Adventists while the current study is small.

Interestingly, private religious activities had a significant positive direct effect on diastolic blood pressure, i.e. the more one conducted private religious activities, the higher was his/her diastolic blood pressure. This contradicts previous studies (Walker et al., 1988). Since the current study was cross sectional, no causality could be implied. It could be that people who had high diastolic blood pressure pray more or read the Bible more because of his/her sickness rather than high diastolic blood pressure being caused by higher frequency of private religious activities.

In the current study, Sabbath-keeping had a significant negative total and direct effect on blood glucose level. In diabetic patients, a higher religiosity is associated with better glycaemic control (Koenig, Parkerson Jr, et al., 1997). Religion might influence glycaemic control through psychosocial pathways. A study that examines psychosocial factors of glycaemic control among diabetic patients found that type II diabetic patients with better self-controlled style of coping had better glycaemic control (Koenig, Hays, et al., 1997). People with higher religiosity might

have better self-control due to doctrinal teaching. Diabetic patients experiencing high stress but better social support had lower level of glycosylated haemoglobin (Haley et al., 2001). People who attend religious functions regularly might have better social support and thus better glycaemic control. However, it is unknown whether the negative association between religion and blood glucose level could also be found among the non-diabetic person, which were the case in the current study. The negative association could be a Sabbath effect. Psychological stress is associated with higher blood glucose level (Wing et al., 1985); since the blood glucose level of the participants were measured on Sabbath after religious service, the participants might be more relaxed than other days.

Most of the coefficients of religiosity and diet mediator were very small and all were insignificant. This contradicted the previous section, where in the multiple regressions it was found that religiosity was positively associated with dietary habit. The main reason could be that the sample size for this analysis was small; only 100 of the 574 participants participated in the health screening. The 100 participants might be different from the rest of the sample. Another reason could be that this was a convenience sample; congregations participated in health screening voluntarily and those that refused to participate might have different congregants.

CHAPTER 9: CONCLUSIONS

This chapter summarizes the main findings of this study and discusses the implications of the findings. Limitations and recommendations for future research are included.

8.1. Summary of Main Findings

Religiosity was positively associated with dietary habits and vegetarian status at individual level. However, congregational conservativeness was associated only with dietary habits above and beyond individual factors. None of the religious variable was associated with fruit and vegetable intake at individual and congregational level. Social gradient remained in the dietary habits of the participants; a higher level of education was positively and significantly associated with dietary habits. Health behaviours did not mediate the relationship between religiosity and health outcomes; the direct effect of religiosity on health outcomes was more important than the indirect effect.

8.2. Strengths of the Study

The strength of this study was the use of single-denomination, which removed the need to control for denominational differences (Lee et al., 2009). The results of the study showed that even within a health conscious denomination, religiosity still play a role in the adoption of a healthy diet.

Another strength of the study was that one of the dietary measures was a scale that measures dietary habits. Diet is “the kinds of food that a person... habitually

eats" ("Diet," 2015), and the dietary habit scale examined diet more holistically; it measured nine dimensions of a diet and not just intake of certain food groups. Compared with the fruit and vegetable intake and vegetarian status, the positive association between the religiosity and dietary habit scale was more informative and comprehensive.

8.3. Limitations and Recommendations for Future Research

Some limitations should be noted in this study. First is related to measurements. This study included only four dimensions of religiosity, which is a multi-dimensional construct. Other important religiosity measures, such as religious coping and religious support, were not included in this study. The Duke University Religion Index (DUREL), which was used to measure religious attendance, private religious activities and intrinsic religiosity in this study, is not an in-depth measure of religiosity (Koenig & Bussing, 2010). The intrinsic religiosity subscale of the DUREL had low Cronbach's alpha in this study ($\alpha=0.60$). In addition, a simple measure of congregational conservativeness was used; the local church pastors were asked to rate the congregational conservativeness based on the ten-point scale.

Second, this study included three dimensions of diet, none of which was a detailed record of dietary intake. Dietary record, the "golden standard" in dietary research where the respondents record all food and beverage consumed within a period (Thompson & Byers, 1994), was not used in this study.

Third, the study is cross-sectional and no causal association could be indicated. While it is more likely that religiosity precedes better dietary habit and vegetarianism rather than vice versa, it is possible that Adventists who practice healthy lifestyle are more likely to be drawn to attend church more and are more religious, rather than religion *per se* that have a positive influence on lifestyle. In addition, some other variables may be affecting this relationship too.

Fourth, the responses to questionnaires were self-reported and might be affected by recall or social desirability biases. The latter bias may reflect the apparent congregational effect, rather than a truly healthier diet. That is, members of more conservative congregations may be more likely to report diets that are more doctrinally consistent.

Fifth, even though there is official statistics about the membership of Adventists in West Malaysia, the record has not been updated regularly and the exact number of Adventists in West Malaysia is unknown. Efforts have been made to recruit as many Adventists in West Malaysia as possible. However, those who refused to or did not participate might have different characteristics than those who participated.

Sixth, about 18% of the participants answered the online questionnaire, which was promoted in social media, phone applications and emails. This might be the reason of the young average age of the participants, since the younger generation is savvier in technology. The elderly Adventists who were illiterate, bed-ridden or

have poor eyesight did not participate in the survey. Since most Adventists of this study were recruited through pastors/elders during worship service, those who did not attend worship during that particular week when questionnaires were administered were left out from the study and they might have different characteristics from those who participated. Effort had been made to recruit the inactive Adventists who rarely or no longer attend worship services through online survey. However, it is unknown how many were missed out.

Finally, the current study included only one denomination in Malaysia, and the results should not be generalised to other denominations where diet was not so centrally important. Nonetheless, the results do point to the potential role of religious communities in health promotion, particularly where the health promotion message and the doctrinal message are consonant.

While not strictly a limitation, it should be remembered that, Malays, the major ethnic group in Malaysia which makes up about 60% of the population, were not included in the study. Malays are necessarily Muslim, and not permitted to be Adventists. They have a different diet from the other ethnic groups in Malaysia and the results are unlikely to generalize in any way to them.

Taking into considerations of the limitations of the current study, future research should include other dimensions of religiosity such as religious coping and religious support and use better dietary measures to shed more light on the relationship between religiosity and diet. The congregational conservativeness

measure could also benefit from additional refinement. Longitudinal studies following individuals prior to formal conversion to the Adventist church may elucidate the relationship better. Similar single-denominational studies conducted on other religions or Christian denomination, especially those that have specific dietary guidelines such as Mormonism and Islam, might also help in understanding the relationship between religiosity and diet.

8.4. Implications of the Findings

Despite its limitations, the current study showed a connection between individual religiosity, congregational conservativeness and diet. Even among a health-conscious Christian group, religiosity is still significantly associated with diet. This study has several implications for public health, especially in the promotion of healthy eating.

Religious communities are one of the very few places where people from different socioeconomic status and ethnic and cultural background gather regularly, thus religious communities present an ideal channel to conduct health promotion activities (Koenig, 2008b), especially in communities where there is a lack of access or resources for non-religious health promotion programmes. Compared with hospitals and other clinical settings, religious congregations present a non-threatening and supportive environment for health promotion (Saharyildizi, 2006). The results of the current study show that religious congregations could be a potential channel to promote health, especially among those who are difficult to reach due to lack of health education and poor access to health care.

Religion is experienced differently in different groups of people: Africans in the U.S tend to be more religiously active than Whites (Taylor et al., 1996); females are more religious than males (Loewenthal et al., 2002); and older people are generally more religious than young people (Hout et al., 2013). In addition, religion might influence health and health behaviours differently in different ethnic groups. For example, overall African Americans have poorer health than the Whites (Donahue, 1985), however, African Americans who are more religious have better health than African Americans who are less religious, and this correlation is not as strong as in Whites (Drevenstedt, 1998; Ferraro & Koch, 1994; Krause, 2002). Given the central role of religion in the lives of Blacks Americans, many faith-based health promotion projects have been conducted successfully in African churches in increasing fruit and vegetable intake (Campbell et al., 1999), producing clinically significant weight loss (McNabb et al., 1997), and improving cardiovascular diseases risk profiles among African Americans (Yanek et al., 2001), who have relatively poorer health and health outcomes.

The type of health promotion programmes could be tailored to fit the teaching of the church. For example, while many studies have shown that religiosity is positively associated with increased fruit and vegetable intake, the current study showed that it was not so in Adventists. Most other Christian denominations do not teach about health as much as the Adventists. For Adventist churches or other churches that have health-related doctrines, health promotion programs could be more specific while for denominations that do not have health-related doctrines, health promotion program should be more general.

In Christian churches pastors are seen as trusted, respected and credible leaders, and have significant influence on the types of health-related activities being offered in their churches (Baruth et al., 2015; Bopp et al., 2013). In fact, the effectiveness of faith-based health promotion programmes is moderated by faith leaders (Peterson et al., 2002) and pastors should be included as active participants in faith-based health promotion programmes. Pastors are significantly involved in offering faith-based health counselling, however, they may lack self-efficacy (Fallon et al., 2013). To address this issue, theological seminary should provide training on health counselling. Another way to promote health within a religious community is through improving the health of faith leaders. Research has shown that congregations with faith leaders' who were more physically active and consumed more fruit and vegetables also tended to engage in more health and wellness activities (Bopp & Fallon, 2011).

Socioeconomic status (SES) has been shown to be significantly associated with health, and social gradient that exists in many health outcomes and health behaviours remains an important challenge in health promotion. In the current study, the sub-studies that examined individual and congregational characteristics and diet showed that religion could be a potential channel to promote health and to overcome social gradient in health and health behaviours. However, the results from the social gradient and dietary habits sub-study showed that social gradient still existed even in the dietary habits of Adventists, a group of health-conscious Christians.

The social gradient might be due to the differences in exposure to health-related messages. In a study that examined area deprivation and exposure to health promotion materials on HPV vaccination, it was found that schools located in the least deprived area had significantly higher odds of requesting health promotion materials than those located in the most deprived area, and there was also a significant trend where decreasing deprivation was significantly associated with more requests of health promotion materials (Chivu & Reidpath, 2010). In other words, there was a social gradient in the exposure to health promotion materials. Initially it was assumed that since the Adventists are similarly exposed to healthy living due to Bible study and church-related health activities. However, this might not be the case. Those who are more educated might be more exposed to health messages because of the church they are attending. It is likely that people attend churches that are nearest to their homes. Since a higher level of education is associated with higher income (Martins & Pereira, 2004), it is possible that those who are more educated tend to live in affluent areas and attend more affluent churches, which have more financial resources to conduct health activities. Rather than being a place where people from all walks of life gather together, as mentioned earlier in this section, a church might be a place where people of a status flock together. The implication for public health is that when religious institutions are considered for health promoting programmes, the SES of the members and areas where the religious institutions are located should be taken into account too. To improve exposure to health promotional materials, churches or other religious institutions located at deprived areas should be targeted for more health promotional activities. Perhaps the best way to reach out to the most

disadvantaged is through the religious institutions that are located at the disadvantaged area.

Christian denominations generally have weekly religious services and other religious gathering during the weekdays. As a result, members of a Christian denomination tend to have more social interactions. Even in mega churches, many members belong attend cell groups, where those who live in a certain area gather together regularly during weekdays. In addition, Christian churches tend to keep a membership record of when and how a person joins the church. Since the sample of this study was a group of Christians, the results of this study might apply more to other Christians or religions that meet weekly or regularly, have close relationship among the members, and keep membership record. The results might not be applicable to religions that do not keep membership record and do not have regular meeting, such as Buddhism and Hinduism, and also in religions where certain groups of people are excluded from the regular meeting, such as Islam in Malaysia, where females are not required to attend the weekly Friday worship.

In conclusion, the findings of this study provide a significant opportunity for health professionals to improve health promotion program by accommodating and understanding participants' religious beliefs. While it is impossible to manipulate a person's religiosity and unethical to "prescribe" religious intervention or activities, he or she could be encouraged to participate in more public and private religious activities.

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APPENDIX

A. List of Adventist Congregations in West Malaysia

1. Alor Setar SDA Company
2. Bagan Datoh SDA Indian Church
3. Banting SDA Indian Church*
4. Bukit Jelutong SDA Indian Company*
5. Damansara Adventist Hope Centre*
6. Farlim SDA Church
7. Ipoh SDA Chinese Church
8. Ipoh SDA English Church
9. Johor Bahru SDA BM Church
10. Johor Bahru SDA English Church
11. Johor Bahru SDA Indian Church
12. Klang SDA BM Company*
13. Klang SDA Indian Company*
14. Klebang SDA Indian Church
15. Kluang SDA Group
16. Kota Bharu SDA Chinese Church
17. Kota Masai SDA Group
18. Kuala Lumpur SDA Chinese Church*
19. Kuala Lumpur SDA English Church*
20. Kuala Selangor SDA Indian Group*
21. Kuantan SDA Chinese Company
22. Kulai SDA Chinese Church
23. Kulim SDA Group

24. Kulim SDA Indian Company
25. Megah Ria SDA Company
26. Melaka SDA Church
27. Muar SDA Church
28. Nibong Tebal SDA Indian Company
29. Pandamaran SDA BM Group*
30. Penang Adventist Hospital Church
31. Penang SDA Chinese Church
32. Penang SDA English Church
33. Penang SDA Indian Church
34. Petaling Jaya SDA Chinese Church*
35. Petaling Jaya SDA English Church*
36. Pontian SDA Chinese Church
37. Puchong SDA Chinese Company*
38. Puchong SDA Indian Group*
39. Seremban SDA Church*
40. Shah Alam SDA Indian Church*
41. Skudai SDA Chinese Church
42. Setiawan Indian Group
43. Sungai Petani SDA Group
44. Sungai Way SDA Indian Church*
45. Taiping SDA Church
46. Tampin SDA Group
47. Teluk Intan SDA Indian Church

48. The Lighthouse Company

49. Ulu Tiram SDA Group

50. USJ SDA Church*

51. Utama Beacon Group*

*Located within 100km from Monash University Sunway Campus and where
community health screening

B. Human Ethics Certificate of Approval



Monash University Human Research Ethics Committee (MUHREC)
Research Office

Human Ethics Certificate of Approval

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project Number: CF13/2766 - 2013001483
Project Title: Religion and Healthy Eating among Seventh-Day Adventists in West Malaysia
Chief Investigator: Dr Carina Chan
Approved: From: 24 September 2013 To: 24 September 2018

Terms of approval - Failure to comply with the terms below is in breach of your approval and the Australian Code for the Responsible Conduct of Research.

1. The Chief investigator is responsible for ensuring that permission letters are obtained, if relevant, and a copy forwarded to MUHREC before any data collection can occur at the specified organisation.
2. Approval is only valid whilst you hold a position at Monash University.
3. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
5. The Explanatory Statement must be on Monash University letterhead and the Monash University complaints clause must include your project number.
6. **Amendments to the approved project (including changes in personnel):** Require the submission of a Request for Amendment form to MUHREC and must not begin without written approval from MUHREC. Substantial variations may require a new application.
7. **Future correspondence:** Please quote the project number and project title above in any further correspondence.
8. **Annual reports:** Continued approval of this project is dependent on the submission of an Annual Report. This is determined by the date of your letter of approval.
9. **Final report:** A Final Report should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected date of completion.
10. **Monitoring:** Projects may be subject to an audit or any other form of monitoring by MUHREC at any time.
11. **Retention and storage of data:** The Chief Investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

A handwritten signature in blue ink, appearing to read 'Nip Thomson'.

Professor Nip Thomson
Chair, MUHREC

cc: Prof Dr Daniel Reidpath, Mrs Min Min Tan

Postal – Monash University, Vic 3800, Australia
Building 3E, Room 111, Clayton Campus, Wellington Road, Clayton
Telephone +61 3 9905 5490 Facsimile +61 3 9905 3831
Email muhrec@monash.edu <http://www.monash.edu.au/researchoffice/human/>
ABN 12 377 614 012 CRICOS Provider #00008C

C. Endorsement Letter from Peninsular Malaysia Mission



SEVENTH-DAY
ADVENTIST
CHURCH

Seventh-Day Adventist Corporation (M) Bhd
(248857-D)
22-1 Jalan 2/114, Kuchai Business Centre,
Jalan Kuchai Lama, 58200 Kuala Lumpur, Malaysia.
Tel: (603) 7984 7795 Fax: (603) 7984 4600
E-mail: pem@adventist.org.my
Web: www.adventist.org.my

Local Church Pastors,
Peninsular Malaysia Mission.

15 January 2013

Dear Pastors,

Endorsement for Research "Relationship between Religion and Health Eating among the Seventh-day Adventist in Peninsular Malaysia, 2013-2014"

The Administrative Committee is endorsing the research program of Sister Tan Min Min, a members of the Damansara Adventist Hope Center, among members of the Seventh-day Adventist Church in Peninsular Malaysia Mission for the period of 2013 and 2014 under the Jeffrey Cheah School of Medicine and Health Sciences, of Monash University.

It is hoped that the result of the study would further showcase the life style of Seventh-day Adventist, thus bearing positive evidence when adhering to the counsel of the Spirit of Prophecy and our Health Message.

As the method of implementing this study requires church member's personal information, Sister Tan Min Min will need to obtain the written consent of your respective members prior to implementing this study.

While we look forward to having a majority of the church members participating in this study, it is up the individual churches and members to volunteer their participation.

Thank you in advance for your kind help.

Sincerely,

Pastor Sim Tian Sang
Executive Secretary.

cc : Pastor Leong Fai
: Brother Chee Meng Keen
: Pastor Tan Meng Cheng

D. Facebook Page to Recruit Participants



Adventist Religion & Healthy Eating Study

A study of the relationship between religion/spirituality & diet among the Seventh-Day Adventists in Peninsular Malaysia

TAKE CARE OF YOUR BODY IT'S THE ONLY PLACE YOU HAVE TO LIVE IN

MONASH University Malaysia [Change Cover](#)

Adventist Religion & Healthy Eating Study
281 likes · 17 talking about this

[Update Page Info](#) [Liked](#) [Following](#)

Community
PEM Adventist wanted! :)
This page will keep you updated about the research on the relationship between religion and diet among PEM Adventists.

[About](#) [Photos](#) [Likes](#) [Notes](#)

[Highlights](#)

E. Explanatory Statement for Pastors/Elders



EXPLANATORY STATEMENT Seventh-Day Adventist Church of Peninsular Malaysia

Project: Religion and Healthy Eating among Seventh-Day Adventists in West Malaysia

Carina Chan

Global Public Health, Jeffrey Cheah School of
Medicine
Telephone: 03-55144913
Email: carina.chan@monash.edu

Min Min Tan

PhD Candidate, Jeffrey Cheah School of
Medicine
Telephone : 014-9039230
Email: mmtan13@student.monash.edu

You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

The aim of this study is to investigate the relationship between religion and healthy eating among the Seventh-Day Adventists in Peninsular Malaysia. Specifically, it is to examine how the different aspect of religion is associated with a healthy diet among the Adventists, and how the characteristics of the local congregations are affecting diet choice of their members. This study is conducted as part of the requirement of the degree of Doctor of Philosophy of Min Min.

If you agreed to participate in this study, you will be asked to fill in a questionnaire about your congregation, which will take you about 2 minutes to complete.

Why were you chosen for this research?

You are chosen for this research because you are a full time minister of Peninsular Malaysia Mission. This letter reaches you either through personal communication by Min Min Tan, one of the researchers of this project, or by post.

Consenting to participate in the project and withdrawing from the research

Once you understand what this study is about and if you agree to take part in it, you will be asked to sign the Consent Form. By signing the Consent Form, you indicate that you understand the information and that you give your consent to participate in the research project.

Participation in the study is entirely voluntary. You maintain the right to decline to participate or to withdraw from further participation at any stage of the study without explanation.

Possible benefits and risks to participants

There may not be any direct or immediate benefits for you in participating. However, this study will help to raise awareness about the Seventh-Day Adventist Church and its unique health message. In addition, it will also help to promote healthy eating among the Adventists who are not practicing it and seekers who are intending to join the Church. The results of the study could also be used to reach out to people who have not yet received the health message. Health promotion programs could be planned to meet the needs of the community.

The risks of participating in this study do not exceed those encountered in everyday life. The only inconvenience or discomfort you may experience by participating in this study is the time it will take you to complete the questionnaire.

Confidentiality

Please be assured that your responses will be kept strictly confidential. Individual participants will not be identified in the analysis as only aggregated results will be analysed and presented in academic journal publications and/or conference proceedings.

Storage of data

Monash University has clear guidelines on the procedures concerning the storage of research data. The information you provide for this research will be kept in a locked filing cabinet for the period of 5 years from the completion of the research, after which it will be destroyed. Only the involving researchers of this study will have access to the data.

Use of data for other purposes

The data collected from this study may be used for further study or in writing articles beyond the three years that this study has funding. Only de-identified data will be used in any further analysis and releasing of results.

Results

The results of the study will be available on October 2015. A summary of the results will be sent to you. You may also contact Min Min. The results will be made public at conferences and seminars, and we will publish articles in academic and professional journals and newsletters.

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the representative/executive officer for the Human Research Ethics Committee:

Chua Khong Wai
Senior Manager, Research management
Monash University Sunway Campus
Jalan Lagoon Selatan,
46150 Bandar Sunway,
Selangor.
Telephone: +603-55146053
Fax: +60355146331
email: chua.khong.wai@monash.edu

Thank you,

Carina Chan

F. Questionnaire for Pastors/ Elders

Congregational Conservativeness

?

On a scale of 1 to 10, please rate your church's conservativeness:

?

Very liberal	??	??	??	??	??	Very conservative			
1	2	3	4	5	6	7	8	9	10

?

?

G. Explanatory Statement for Church Members



EXPLANATORY STATEMENT Seventh-Day Adventist Church of Peninsular Malaysia

Project: Religion and Healthy Eating among Seventh-Day Adventists in West Malaysia

Carina Chan

Global Public Health, Jeffrey Cheah School of
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Telephone: +603 5514 4913
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Min Min Tan

PhD Candidate, Jeffrey Cheah School of
Medicine
Telephone : 014-9039230
email: mmtan13@student.monash.edu

You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

The aim of this study is to investigate the relationship between religion and healthy eating among the Seventh-Day Adventists in Peninsular Malaysia. Specifically, it is to examine how the different aspect of religion is associated with a healthy diet among the Adventists, and how the characteristics of the local congregations are affecting diet choice of their members. This study is conducted as part of the requirement of the degree of Doctor of Philosophy of Min Min.

If you agreed to participate in this study, you will be asked to fill in a questionnaire, which will take you about 30 minutes to complete. This questionnaire includes questions about religion, diet, other lifestyle factors, demographics, and self-reported physical measurements.

Why were you invited for this research?

You are invited for this research because you are a baptized member of the Seventh-Day Adventist Church in Peninsular Malaysia and are above 18 years old. This letter reaches you either through personal communication by Min Min, one of the researchers of this project, or your local church pastor.

Consenting to participate in the project and withdrawing from the research

By reading this Explanatory Statement, it will be understood that you have signified consent to participate in this research. Participation in the study is entirely voluntary. You maintain the right to decline to participate or to withdraw from further participation before submitting your responses. Do note that since the questionnaire is anonymous, it will not be possible to withdraw data once you have submitted the responses.

Possible benefits and risks to participants

There may not be any direct or immediate benefits for you in participating. However, this study will help to raise awareness about the Seventh-Day Adventist Church and its unique health message. In addition, it will also help to promote healthy eating among the Adventists who are not practicing it and seekers who are intending to join the Church. The results of the study could also be used to reach out to people who have not yet received the health message. Health promotion programs could be planned to meet the needs of the community.

The risk of participating in this study does not exceed that encountered in everyday life. The only inconvenience or discomfort you may experience by participating in this study is the time it will take you to complete the questionnaire.

Confidentiality

Please be assured that your responses will be kept strictly confidential (i.e. collected in a de-identified form). Individual participants will not be identified in the analysis as only aggregated results will be analysed and presented in academic journal publications and/or conference proceedings.

Storage of data

Monash University has clear guidelines on the procedures concerning the storage of research data. The information you provide for this research will be kept in a locked filing cabinet for the period of 5 years from the completion of the research, after which it will be destroyed. Only the involving researchers of this study will have access to the data.

Use of data for other purposes

The anonymous pool of data collected from this study may be used for further study or in writing articles beyond the three years that this study has funding. Only de-identified data will be used in any further analysis and releasing of results.

Results

The results of the study will be available after 2015. A summary of the results will be sent to your local church pastor, who will distribute it to you. You may also contact Min Min. The results will be made public at conferences and seminars, and we will publish articles in academic and professional journals and newsletters.

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the representative/executive officer for the Human Research Ethics Committee:

Chua Khong Wai
Senior Manager, Research management
Monash University Sunway Campus
Jalan Lagoon Selatan,
46150 Bandar Sunway,
Selangor.
Telephone: +603-55146053
Fax: +60355146331
email: chua.khong.wai@monash.edu

Thank you,

Carina Chan

H. Questionnaire for Church Members



Adventist Religion & Healthy Eating Study



Thanks for participating in this project!

Please read all of the instruction below carefully

1. This is an **anonymous** questionnaire. Please **DO NOT** write your name on any part of the questionnaire.
2. It is important that you answer every question, unless the instructions specifically direct you to skip it.
3. Give the most likely answer to all questions, even if you are not absolutely sure.
4. If you have any questions, feel free to ask Min Min. ☺



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A. Your Religion/Spiritual Life

The following are questions about your religious beliefs and/or involvement. Please circle your answer.

1. How often do you attend church or other religious meetings?
 - a. More than once per week
 - b. Once a week
 - c. A few times a month
 - d. A few times a year
 - e. Once a year or less

2. How often do you spend time in private religious activities, such as prayer, meditation or Bible study?
 - a. More than once per week
 - b. Once a week
 - c. A few times a month
 - d. A few times a year
 - e. Once a year or less

The following section contains 3 statements about religious belief or experience. Please mark the extent to which each statement is true or not true for you.

3. In my life, I experience the presence of God.
 - a. Definitely true of me
 - b. Tends to be true
 - c. Unsure
 - d. Tends not to be true
 - e. Definitely not true

4. My religious beliefs are what really lie behind my whole approach to life.
 - a. Definitely true of me
 - b. Tends to be true
 - c. Unsure
 - d. Tends not to be true
 - e. Definitely not true

5. I try hard to carry my religion over into all other dealings in life.
- a. Definitely true of me
 - b. Tends to be true
 - c. Unsure
 - d. Tends not to be true
 - e. Definitely not true

Sabbath Activities

On average how frequently do you do each of the following on Sabbath?

	Every Sabbath	3 Sabbaths per month	2 Sabbaths per month	1 Sabbath per month	Less often but occasionally	Never
Go shopping	<input type="radio"/>	<input type="radio"/>				
Read secular magazines	<input type="radio"/>	<input type="radio"/>				
Attend secular concerts or theatrical events (watch secular movie)	<input type="radio"/>	<input type="radio"/>				
Watch or listen to news programs	<input type="radio"/>	<input type="radio"/>				

B. Your Diet

Below are statements about your diet. Please circle your answers.

	NEVER	SOMETIMES	OFTEN	ROUTINELY
Choose a diet low in fat, saturated fat, and cholesterol.	1	2	3	4
Limit use of sugars and food containing sugar (sweets).	1	2	3	4
Eat 4-8 *servings of bread, cereal, rice and pasta each day. [<i>*Refer to the pictures in page 8</i>]	1	2	3	4
Eat 2-4 *servings of fruit each day. [<i>*Refer to the pictures in pages 9 and 10</i>]	1	2	3	4
Eat 3-5 *servings of vegetable each day. [<i>*Refer to the pictures in page 11</i>]	1	2	3	4
Eat 1-3 *servings of milk, soy milk, yogurt or cheese each day. [<i>*Refer to the pictures in page 12</i>]	1	2	3	4
Eat only 1-2 *servings from the meat, poultry, fish, beans, eggs and nuts group each day. [<i>*Refer to the pictures in page 12</i>]	1	2	3	4
Read labels to identify nutrients, fats, and sodium (salt) content in packaged food.	1	2	3	4
Eat breakfast	1	2	3	4

1. Which of the following describes your dietary practice?
 - a. I'm a vegan (do not eat any animal product)
 - b. I'm a vegetarian (eat dairy products and/or eggs, but do not eat meat)
 - c. I'm a pesco-vegetarian (eat fish but not other types of meat)
 - d. I'm a non-vegetarian

Go to Question #3

2. How long have you been a vegan/vegetarian? ____ years

These are questions about your fruit and vegetables intake.

3. In a typical week, on how many days do you eat fruit?
___ days
4. How many *servings of fruit do you eat on the day you eat fruit?
[*Refer to the pictures in pages 9 and 10]
___ servings
5. In a typical week, on how many days do you eat vegetables?
___ days
6. How many *servings of vegetables do you eat on the day you eat vegetables? [*Refer to the picture in page 11]
___ servings

[Go to page #13]

1 serving of bread, cereal, rice and pasta =

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1 cup of cooked rice



2 cups of porridge



2 slices of bread



1 cup of noodles/kuey teow



1½ cups of mee hoon



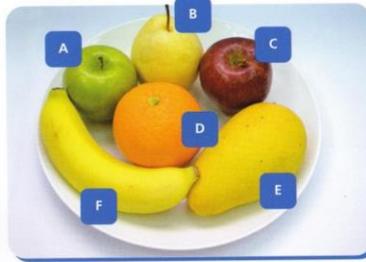
1 cup of cereal



1 cup of sweet potatoes/potatoes/tapioca

1 serving of fruit =

- C1) 1 whole fruit (medium size):
A. 1 green apple
B. 1 Chinese white pear
C. 1 red apple
D. 1 orange
E. 1 banana
F. 1 mango



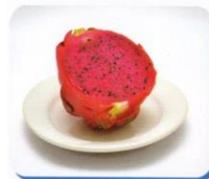
- C2) ½ fruit:



½ guava

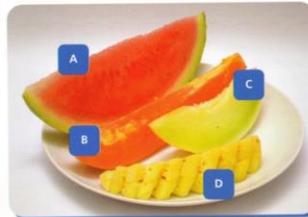


½ green pear



½ dragon fruit

- C3) Sliced fruit:
A. 1 slice of water melon
B. 1 slice of papaya
C. 1 slice of honey dew
D. 1 slice of pineapple



- C4) 2 fruits:



2 star fruits



2 lady finger bananas



2 cikus

1 serving of fruit =

C5) Small fruits:



8 grapes



7 rambutans



8 longans

C6) Fruit in pieces:



2 pieces of durian



4 pieces of jackfruit

C7) Dried fruits:



4 prunes



3 dates

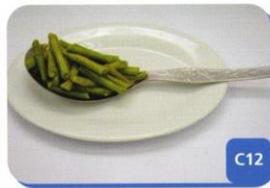


1 tablespoon of raisin

1 serving of vegetables=



- C8) ½ cup of cooked green leafy vegetables
- C9) 1 scoop of cooked green leafy vegetables
- C10) 4 tablespoons of cooked green leafy vegetables



- C11) ½ cup of cooked fruit vegetables
- C12) 1 scoop of cooked fruit vegetables
- C13) 4 tablespoons of cooked fruit vegetables



- C14) ½ cup of carrot
- C15) ½ cup of eggplant
- C16) 1 cup of ulam

1 serving of milk, soy milk, yogurt or cheese=



1 glass (250ml) of milk or soy milk



1 cup of yoghurt



1 slice of cheese

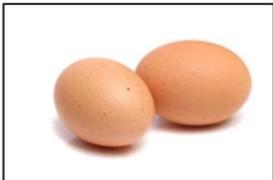
1 serving of meat, poultry, fish, beans, eggs or nuts=



A palm size of meat/poultry/fish



1 cup of cooked beans



2 eggs



A handful of nuts

C. Your Lifestyle

Alcohol Consumption

1. Have you ever consumed an alcoholic drink such as beer, wine, spirits, fermented cider or others?

Go to
page #15

- a. Yes
b. No

2. Have you consumed an alcoholic drink within the past 12 months?

Go to
page #15

- a. Yes
b. No

3. During the past 12 months, how frequently have you had at least one alcoholic drink?

- a. Daily
b. 5-6 days per week
c. 1-4 days per week
d. 1-3 days per month
e. Less than once per month

4. Have you consumed an alcoholic drink within the past 30 days?

- a. Yes
b. No

5. During the past 30 days, on how many occasions did you have at least one alcoholic drink? (Note that there can be more than one occasion in which alcohol is consumed in a given day)

___ occasion(s)

6. During the past 30 days, when you drank alcohol, on average, how many *standard alcoholic drinks did you have during one drinking occasion? [**Refer to the picture in page 14*]

___ drink(s)

7. During the past 30 days, what was the largest number of *standard alcoholic drinks you had on a single occasion, counting all types of alcoholic drinks together? [**Refer to the picture in page 14*]

___ drink(s)

8. If you are a **man**: During the past 30 days, how many times did you have 5 or more *standard alcoholic drinks in a single drinking occasion? [**Refer to the picture below*]
___ times

If you are a **woman**: During the past 30 days, how many times did you have 4 or more *standard alcoholic drinks in a single drinking occasion? [**Refer to the picture below*]
___ times

[Go to page #15]

What is a standard drink*?

Standard drinks measure the amount of pure alcohol you are drinking. One standard drink equals 10 grams of pure alcohol.

Examples of 1 standard drink:

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325ml (1 tin) of beer
Alcohol content >2% & <10%



140ml of wine
Alcohol content 7-15%



150ml toddy/bahar
Alcohol content 7-15%



100ml of tuak/lihing
Alcohol content 7-15%



80ml of montoku
Alcohol content >30%

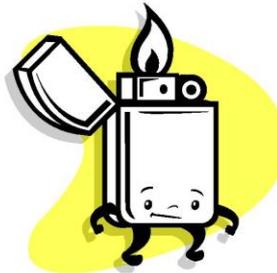


30ml of langkau/samsu/
brandy/whisky
Alcohol content >30%

Smoking

1. Have you ever smoked cigarettes during any period of your life (aside from possibly trying them once or twice)?
 - a. Yes, I currently smoke
 - b. Yes, smoked in the past, but not now
 - c. No, never smoked cigarettes
2. What is the greatest number of cigarettes that you have ever regularly smoked?
 - a. 1/4 pack per day
 - b. 1/2 pack per day
 - c. 1 pack per day
 - d. 1 1/2 pack per day
 - e. 2 packs per day or more
3. At what age did you start smoking regularly? ____ years old
4. If you are not now smoking, at what age did you last stop?
____ years old

Go to
page #16



Exercise

1. During a typical 7-day period (a week), how many times on the average do you do the following kinds of exercise for more than 15 minutes during your free time? Write on each line the appropriate number.

<p>a) STRENOUS EXERCISE (HEART BEATS RAPIDLY) e.g. running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)</p>	<p>___times per week</p>
<p>b) MODERATE EXERCISE (NOT EXHAUSTING) e.g. fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, popular and folk dancing</p>	<p>___times per week</p>
<p>c) MILD EXERCISE (MINIMAL EFFORT) e.g. yoga, archery, fishing from river bank, bowling, golf, easy walking</p>	<p>___times per week</p>

2. During a typical 7-day period (a week), in your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?
- Often
 - Sometimes
 - Never/rarely



D. Your Health

Physical Measurement

1. What is your height? _____ cm
2. What is your weight? _____ kg
3. What is your waist circumference? _____ inches
4. What is your hip circumference? _____ inches



History of Diabetes

1. Have you ever had your blood sugar measured by a doctor or other health worker?
 Yes
 No
2. Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?
 Yes
 No
3. Have you been told that you have raised blood sugar or diabetes in the past 12 months?
 Yes
 No

History of Raised Blood Pressure

1. Have you ever had your blood pressure measured by a doctor or other health worker?
 Yes
 No

2. Have you ever been told by a doctor or other health worker that you have raised blood pressure or hypertension?
 Yes
 No

3. Have you been told about your raised blood pressure or hypertension in the past 12 months?
 Yes
 No



7. Which of the following best describes your main work status over the past 12 months?
- a. Government employee
 - b. Semi government employee
 - c. Non-government employee
 - d. Self-employed
 - e. Non-paid
 - f. Homemaker
 - g. Student
 - h. Unemployed
 - i. Retired
8. What is your monthly household income?
- a. Less than RM400
 - b. RM400-RM699
 - c. RM700-RM999
 - d. RM1000-RM1999
 - e. RM2000-RM2999
 - f. RM3000-RM3999
 - g. RM4000-RM4999
 - h. RM5000 & above
9. At what age were you first baptized into the Adventist church?
_____ years old
10. Were you born into an Adventist family?
- Yes
 - No
11. Where is your current church membership held?

**The end of questionnaire
Thank you!**

FOR HEALTH SCREENING ONLY. PLEASE DO NOT FILL IN THIS PART.

Community Health Screening

Adventist: Yes No

Adventist membership: _____

Height	m	
Weight	kg	
BMI		
Blood pressure	Reading 1	Systolic (mmHg)
		Diastolic (mmHg)
	Reading 2	Systolic (mmHg)
		Diastolic (mmHg)
	Reading 3	Systolic (mmHg)
		Diastolic (mmHg)
Blood glucose (random)	mmol/l	

Waist circumference : _____ cm

Hip circumference : _____ cm

I. Explanatory Statement for Health Screening



EXPLANATORY STATEMENT Seventh-Day Adventist Church of Peninsular Malaysia

Project: Religion and Healthy Eating among Seventh-Day Adventists in West Malaysia

Carina Chan

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You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

The aim of this study is to investigate the relationship between religion and healthy eating among the Seventh-Day Adventists in Peninsular Malaysia. One of the sub-objectives of this study is to find out the prevalence of obesity, hypertension and diabetes among the Adventists, as these diseases are diet-related. This study is conducted as part of the requirement of the degree of Doctor of Philosophy of Min Min.

If you agreed to participate in this study, you will undergo a health screening, where your physical measurements, which include height, weight, blood glucose level, and blood pressure will be taken. The entire process will take about 30 minutes.

Why were you chosen for this research?

You are chosen for this research because you are a baptized Seventh-Day Adventist whose membership is held in Peninsular Malaysia Mission and are above 18 years old. This letter reaches you through personal communication by Min Min, one of the researchers of this project.

Consenting to participate in the project and withdrawing from the research

Once you understand what this study is about and if you agree to take part in it, you will be asked to sign the Consent Form. By signing the Consent Form, you indicate that you understand the information and that you give your consent to participate in the research project.

Participation in the study is entirely voluntary. You maintain the right to decline to participate or to withdraw from further participation at any stage of the study without explanation.

Possible benefits and risks to participants

The health screening will help you to find out your current health status and whether you are at risk of obesity, hypertension or diabetes. It will also help to determine the prevalence of the diseases among Adventists in Peninsular Malaysia so that the Mission will be able to plan health promotion programs that will meet the needs of local congregations.

The risks of participating in this study do not exceed those encountered in everyday life. The inconvenience or discomfort you may experience by participating in this study is the pricking of fingertips for blood glucose test, and the time it will take you to complete the health screening.

In case you are found to be at risk of obesity, hypertension or diabetes, medical advice will be provided during the health screening.

Confidentiality

Please be assured that your responses will be kept strictly confidential. Individual participants will not be identified in the analysis as only aggregated results will be analysed and presented in academic journal publications and/or conference proceedings.

Storage of data

Monash University has clear guidelines on the procedures concerning the storage of research data. The information you provide for this research will be kept in a locked filing cabinet for the period of 5 years from the completion of the research, after which it will be destroyed. Only the involving researchers of this study will have access to the data.

Use of data for other purposes

The anonymous pool of data collected from this study may be used for further study or in writing articles beyond the three years that this study has funding. Only de-identified data will be used in any further analysis and releasing of results.

Results

The results of the health screening will be available to you right after the procedures. As for the overall prevalence of obesity, hypertension and diabetes of the Adventist churches in Peninsular Malaysia, it will be available on October 2015. A summary of the overall results will be sent to your local church. You may also contact Min Min. The results will be made public at conferences and seminars, and we will publish articles in academic and professional journals and newsletters.

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the representative/executive officer for the Human Research Ethics Committee:

Chua Khong Wai
Senior Manager, Research management
Monash University Sunway Campus
Jalan Lagoon Selatan,
46150 Bandar Sunway,
Selangor.
Telephone: +603-55146053
Fax: +60355146331
email: chua.khong.wai@monash.edu

Thank you,

(insert Chief Investigator's signature)

Daniel Reidpath

J. Informed Consent Form for Health Screening



CONSENT FORM

Seventh-Day Adventist Church of Peninsular Malaysia

Project: Religion and Healthy Eating among Seventh-Day Adventists in West Malaysia

Chief Investigator: Carina Chan

I have been asked to take part in the Monash University research project specified above. I have read and understood the Explanatory Statement and I hereby consent to participate in this project.

I consent to the following:	Yes	No
To allow the researchers to take my physical measurements, which include weight, height, blood glucose level and blood pressure	<input type="checkbox"/>	<input type="checkbox"/>
To allow the researchers to use the data that I provide during this research in future research projects	<input type="checkbox"/>	<input type="checkbox"/>

I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

I understand that any data used in reports or published findings will not, under any circumstances, be personally identifiable. I also understand that data from the physical measurements will be kept in a secure storage and accessible to the research team. I also understand that the data will be destroyed after a 5-year period.

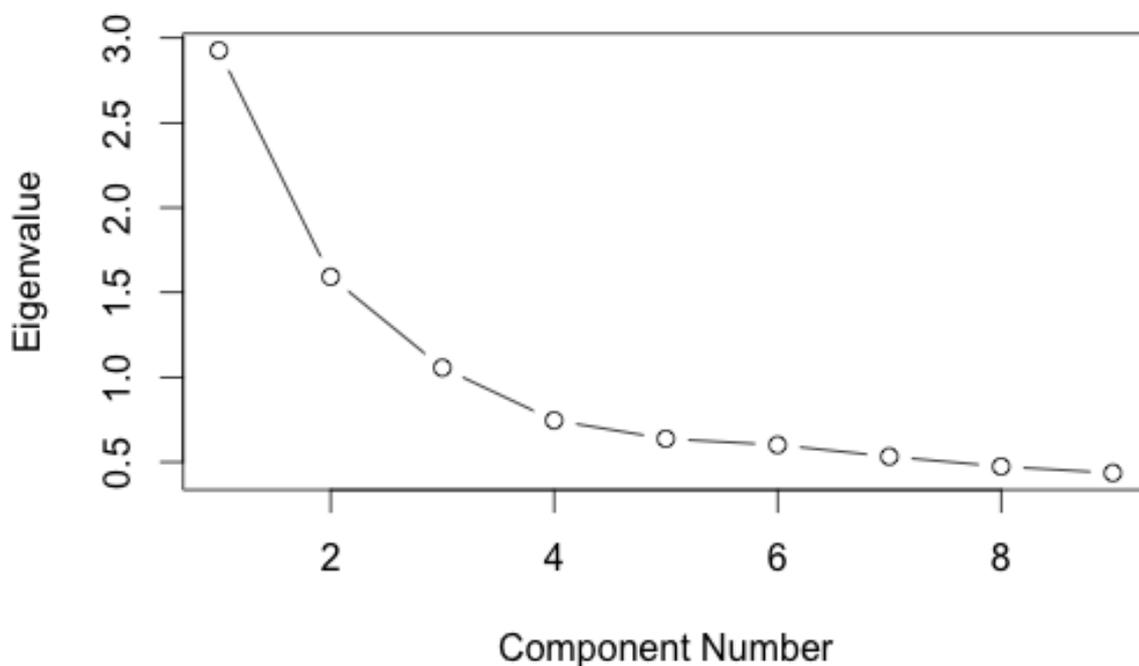
Name of Participant _____

Participant Signature _____ Date _____

K. Principal Components Analysis Results

Since there were a total of nine items from the religious variables, a nine-factor PCA was conducted. A scree plot was obtained (see Figure 9) and it shows that three of the nine components have Eigen value more than 1 and explained most of the variability.

Figure 7. Scree plot of religious variables.



Rotation is “a variety of methods to further analyse initial PCA results” to make “the pattern of loadings clearer, or more pronounced” (Brown, 2009) so that the results are more interpretable. Rotated principal components are not principal components but merely components (Revelle, 2015). There are two types of rotation: orthogonal, and oblique. Orthogonal rotation forces the components to be uncorrelated while oblique rotation permits correlations among components (Richman, 1986). To decide on the type of rotation, oblique rotation was first

conducted; if the correlations among the components are less than 0.32, orthogonal rotation would be used subsequently (Tabachnick & Fidell, 2013). A three-factor PCA with direct oblimin rotation, a type of oblique rotation, was conducted. The resulting correlation matrix of the components is shown in Table 26.

Table 26. Correlation matrix for the three components in the PCA with oblimin rotation.

	Component 1	Component 2	Component 3
Component 1	1.00	-0.16	-0.24
Component 2		1.00	0.23
Component 3			1.00

None of the correlations exceed 0.32, thus an orthogonal rotation was used subsequently. A three-factor PCA with varimax rotation, the most popular orthogonal rotation (Abdi, 2003), was conducted and the resulting loadings are shown in Table 3 (only loadings exceeding 0.30 are displayed).

Table 27. Standardized loadings of varimax rotated PCA of religious variables.

Item	C ₁	C ₂	C ₃	h ²	u ²	com
Secular Activities on Sabbath #1	0.81			0.66	0.34	1.0
Secular Activities on Sabbath #2	0.78			0.63	0.37	1.1
Secular Activities on Sabbath #4	0.77			0.60	0.40	1.0
Secular Activities on Sabbath #3	0.74			0.57	0.43	1.1
Intrinsic Religiosity #1		0.77		0.59	0.41	1.0
Intrinsic Religiosity #2		0.76		0.59	0.41	1.1
Intrinsic Religiosity #3		0.65		0.47	0.53	1.2
Religious Attendance			0.87	0.78	0.22	1.1
Private Religious Activities		0.32	0.76	0.69	0.31	1.4

C = components loadings from the pattern matrix; h² = communality estimate of each item; u² = the uniqueness; com = Hoffman's index of complexity of each item

The Sabbath-keeping items and intrinsic religiosity items clustered among themselves closely, indicating that they are two distinctive scales. Religious attendance and private religious activities, both single-item, clustered with each other. However, in this study, these two subscales were kept separated rather being summed into one scale based on the recommendation of their authors (see section 3.4.3.1-3)

L. Multiple Regression Models for Individual Religiosity and Diet

L.1. Multiple Linear Regression Models

The bivariate models for dietary habits and the other three religious variables are specified below:

$$DH = \beta_0 + \beta_1(\text{Private religious activities}) + \varepsilon$$

$$DH = \beta_0 + \beta_1(\text{Intrinsic Religiosity}) + \varepsilon$$

$$DH = \beta_0 + \beta_1(\text{Religious Attendance}) + \varepsilon$$

where DH denotes dietary habit, β_0 is the intercept, β_1 is regression coefficient, and ε is the error term.

The bivariate models for fruit and vegetable intake are specified below:

$$FV = \beta_0 + \beta_1(\text{Private religious activities}) + \varepsilon$$

$$FV = \beta_0 + \beta_1(\text{Intrinsic Religiosity}) + \varepsilon$$

$$FV = \beta_0 + \beta_1(\text{Religious Attendance}) + \varepsilon$$

where FV denotes fruit and vegetable intake, β_0 is the intercept, β_1 is regression coefficient and ε is the error term.

In the multivariate models, the covariates (age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether they are born into an Adventist family) were entered to determine whether there was a significant relationship between the religious variables and the dietary variables. The models for dietary habits are specified below:

$$\text{DH} = \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Ethnicity}) + \beta_4(\text{Marital Status}) + \beta_5(\text{Employment}) + \beta_6(\text{Income}) + \beta_7(\text{Education}) + \beta_8(\text{Age of Baptism}) + \beta_9(\text{Born in Adventist Family}) + \beta_{10}(\text{Private Religious Activities}) + \varepsilon$$

$$\text{DH} = \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Ethnicity}) + \beta_4(\text{Marital Status}) + \beta_5(\text{Employment}) + \beta_6(\text{Income}) + \beta_7(\text{Education}) + \beta_8(\text{Age of Baptism}) + \beta_9(\text{Born in Adventist Family}) + \beta_{10}(\text{Intrinsic Religiosity}) + \varepsilon$$

$$\text{DH} = \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Ethnicity}) + \beta_4(\text{Marital Status}) + \beta_5(\text{Employment}) + \beta_6(\text{Income}) + \beta_7(\text{Education}) + \beta_8(\text{Age of Baptism}) + \beta_9(\text{Born in Adventist Family}) + \beta_{10}(\text{Sabbath Keeping}) + \varepsilon$$

where DH denotes dietary habit, β_0 is the intercept, β_1 - β_{10} are regression coefficient, and ε is the error term.

The model for fruit and vegetable intake are specified below:

$$\text{FV} = \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Ethnicity}) + \beta_4(\text{Marital Status}) + \beta_5(\text{Employment}) + \beta_6(\text{Income}) + \beta_7(\text{Education}) + \beta_8(\text{Age of Baptism}) + \beta_9(\text{Born in Adventist Family}) + \beta_{10}(\text{Private Religious Activities}) + \varepsilon$$

$$\text{FV} = \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Ethnicity}) + \beta_4(\text{Marital Status}) + \beta_5(\text{Employment}) + \beta_6(\text{Income}) + \beta_7(\text{Education}) + \beta_8(\text{Age of Baptism}) + \beta_9(\text{Born in Adventist Family}) + \beta_{10}(\text{Intrinsic Religiosity}) + \varepsilon$$

$$\text{FV} = \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Ethnicity}) + \beta_4(\text{Marital Status}) + \beta_5(\text{Employment}) + \beta_6(\text{Income}) + \beta_7(\text{Education}) + \beta_8(\text{Age of Baptism}) + \beta_9(\text{Born in Adventist Family}) + \beta_{10}(\text{Sabbath Keeping}) + \varepsilon$$

where FV denotes dietary habit, β_0 is the intercept, β_1 - β_{10} are regression coefficients, and ε is the error term.

L.2. Multiple Logistic Regression

The bivariate models for vegetarian status and the other three religious variables are specified below models are specified below:

$$P(\text{Vegetarian}) = \frac{1}{1 + e^{-(\beta_0 + \beta_1(\text{Private Religious Activities}))}}$$

$$P(\text{Vegetarian}) = \frac{1}{1 + e^{-(\beta_0 + \beta_1(\text{Intrinsic Religiosity}))}}$$

$$P(\text{Vegetarian}) = \frac{1}{1 + e^{-(\beta_0 + \beta_1(\text{Sabbath Keeping}))}}$$

where $P(\text{Vegetarian})$ denotes the probability of being vegetarian, β_0 is the intercept, and β_1 is regression coefficient.

In the multivariate models, the covariates (age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether they are born into an Adventist family) were entered to determine whether there was a significant relationship between the religious variables and vegetarian status. The models are specified below:

$$P(\text{Vegetarian})$$

$$= \frac{1}{1 + e^{-(\beta_0 + \beta_1(A) + \beta_2(G) + \beta_3(E) + \beta_4(MS) + \beta_5(In) + \beta_6(Edu) + \beta_7(AB) + \beta_8(AF) + \beta_{10}(RA))}}$$

$$P(\text{Vegetarian})$$

$$= \frac{1}{1 + e^{-(\beta_0 + \beta_1(A) + \beta_2(G) + \beta_3(E) + \beta_4(MS) + \beta_5(In) + \beta_6(Edu) + \beta_7(AB) + \beta_8(AF) + \beta_{10}(PRA))}}$$

$$P(\text{Vegetarian})$$

$$= \frac{1}{1 + e^{-(\beta_0 + \beta_1(A) + \beta_2(G) + \beta_3(E) + \beta_4(MS) + \beta_5(In) + \beta_6(Edu) + \beta_7(AB) + \beta_8(AF) + \beta_{10}(IR))}}$$

$P(\text{Vegetarian})$

$$= \frac{1}{1 + e^{-(\beta_0 + \beta_1(A) + \beta_2(G) + \beta_3(E) + \beta_4(\text{MS}) + \beta_5(\text{E}) + \beta_6(\text{In}) + \beta_7(\text{Edu}) + \beta_8(\text{AB}) + \beta_9(\text{AF}) + \beta_{10}(\text{SK}))}}$$

where $P(\text{Vegetarian})$ denotes the probability of being vegetarian, β_0 is the intercept, and β_1 - β_{10} are regression coefficients, A=age, G=gender, E=ethnicity, MS=marital status, In=income, Edu=education, AB=age of baptism, AF=born in Adventist family, PRA=private religious activities, IR=intrinsic religiosity, SK=Sabbath keeping.

M. Multilevel Regression Models

M.1. Multilevel Linear Regressions

Models 2. Models 2 built on model 1 and added individual religious variables. The models are specified as below:

$$\text{Diet}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Private Religious Activities})_{ij} + u_{0j} + r_{ij}$$

$$\text{Diet}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Intrinsic Religiosity})_{ij} + u_{0j} + r_{ij}$$

$$\text{Diet}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Sabbath-Keeping})_{ij} + u_{0j} + r_{ij}$$

Models 3. Models 3 built on model 2 and included congregational size and conservativeness. The models are specified below:

$$\text{Diet}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Private Religious Activities})_{ij} + \beta_{11}(\text{Congregational Conservativeness})_{ij} + \beta_{12}(\text{Congregational Size})_{ij} + u_{0j} + r_{ij}$$

$$\text{Diet}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Intrinsic Religiosity})_{ij} + \beta_{11}(\text{Congregational Conservativeness})_{ij} + \beta_{12}(\text{Congregational Size})_{ij} + u_{0j} + r_{ij}$$

$$\text{Diet}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Sabbath-Keeping})_{ij} + \beta_{11}(\text{Congregational Conservativeness})_{ij} + \beta_{12}(\text{Congregational Size})_{ij} + u_{0j} + r_{ij}$$

M.2. Multilevel Logistic Regressions

Models 2. Models 2 built on model 1 and added individual religious variables. In this section, only models including religious attendance are provided. Models including other religious variables are found in Appendix *. The model is specified as below:

$$\text{Veg}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Religious Attendance})_{ij} + u_{0j}$$

$$\text{Veg}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Private Religious Activities})_{ij} + u_{0j}$$

$$\text{Veg}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Intrinsic Religiosity})_{ij} + u_{0j}$$

$$\text{Veg}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Sabbath-Keeping})_{ij} + u_{0j}$$

Models 3. Model 3 built on model 2 and included congregational size and conservativeness. The models are specified below:

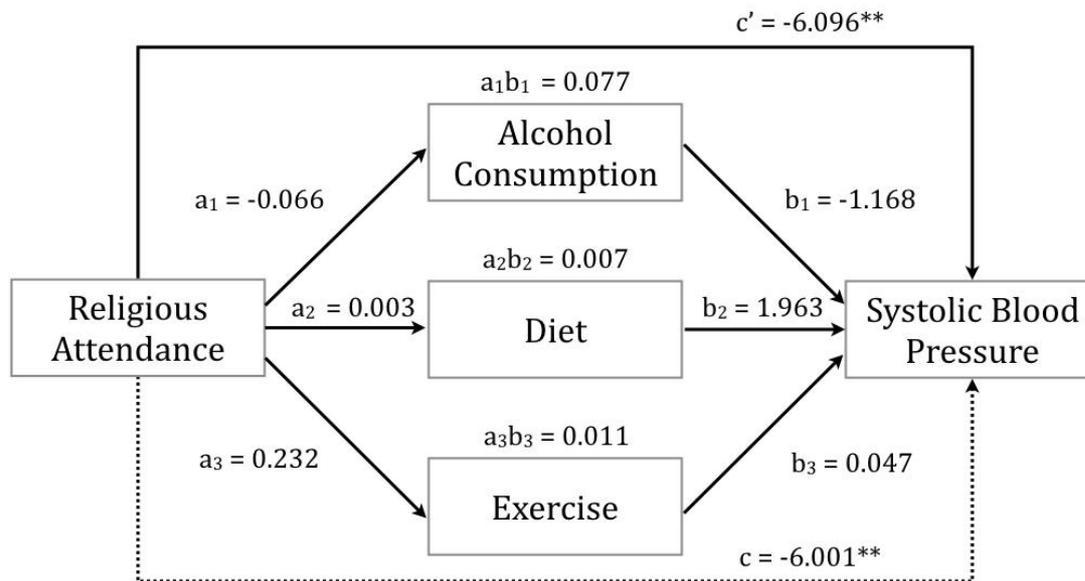
$$\text{Veg}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Private Religious Activities})_{ij} + \beta_{11}(\text{Congregational Conservativeness})_{ij} + \beta_{12}(\text{Congregational Size})_{ij} + u_{oj}$$

$$\text{Veg}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Intrinsic Religiosity})_{ij} + \beta_{11}(\text{Congregational Conservativeness})_{ij} + \beta_{12}(\text{Congregational Size})_{ij} + u_{oj}$$

$$\text{Veg}_{ij} = \gamma_{00} + \beta_1(\text{Age})_{ij} + \beta_2(\text{Gender})_{ij} + \beta_3(\text{Ethnicity})_{ij} + \beta_4(\text{Marital Status})_{ij} + \beta_5(\text{Employment})_{ij} + \beta_6(\text{Income})_{ij} + \beta_7(\text{Education})_{ij} + \beta_8(\text{Age of Baptism})_{ij} + \beta_9(\text{Adventist Family})_{ij} + \beta_{10}(\text{Sabbath-Keeping})_{ij} + \beta_{11}(\text{Congregational Conservativeness})_{ij} + \beta_{12}(\text{Congregational Size})_{ij} + u_{oj}$$

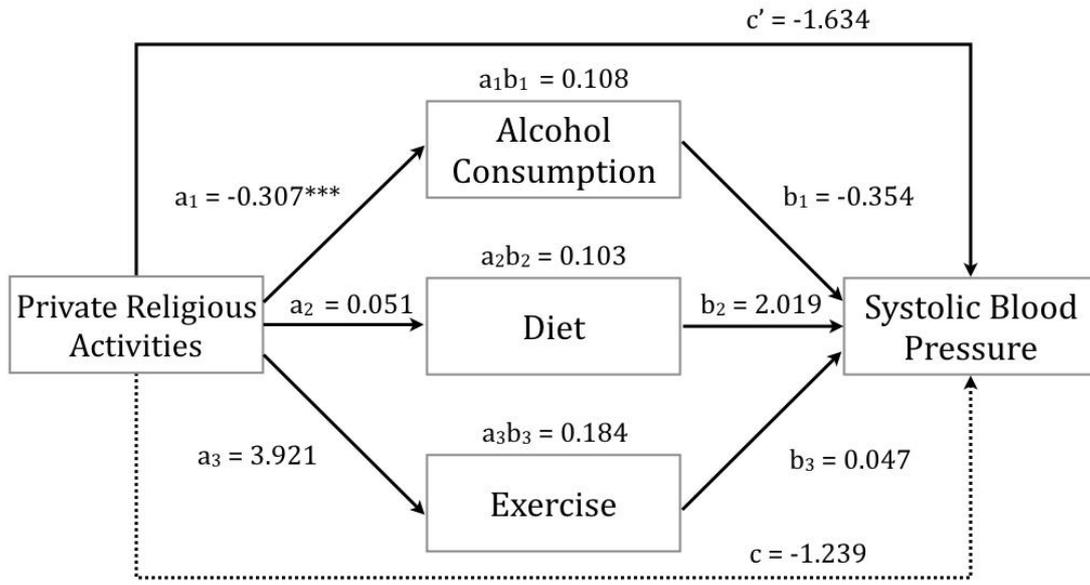
N. Path Diagrams

Figure 8. Effects of religious attendance on systolic blood pressure.



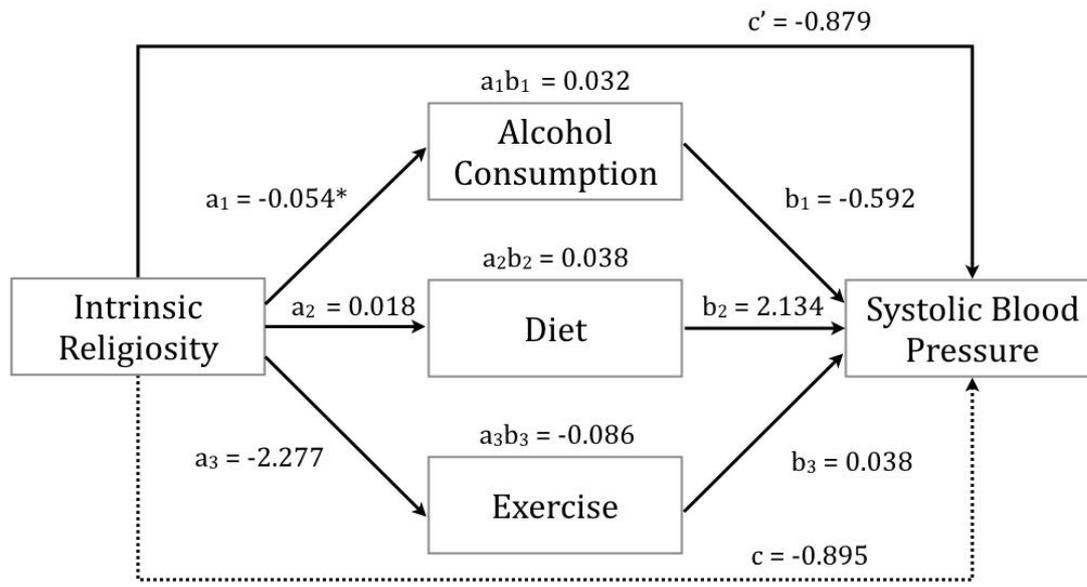
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 9. Effects of private religious activities on systolic blood pressure.



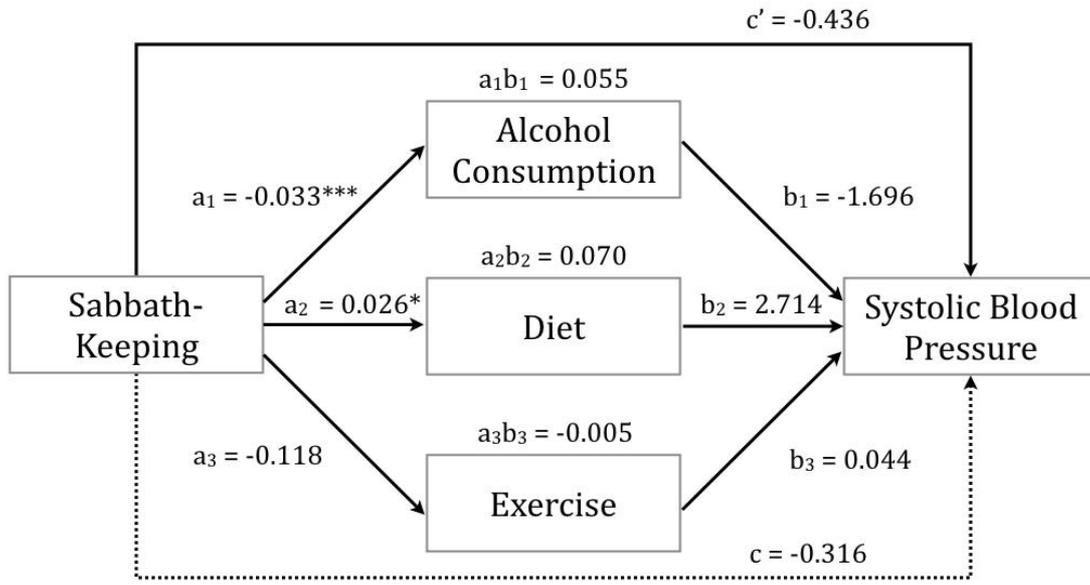
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 10. Effects of intrinsic religiosity on systolic blood pressure.



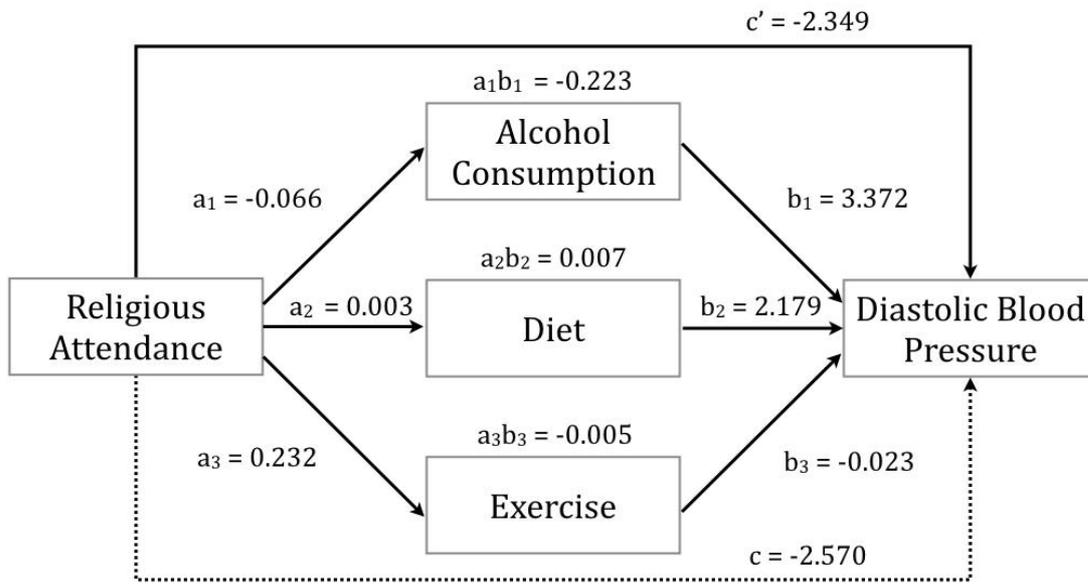
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 $*$: $P < 0.05$; $**$: $P < 0.01$; $***$: $P < 0.001$

Figure 11. Effects of Sabbath-keeping on systolic blood pressure.



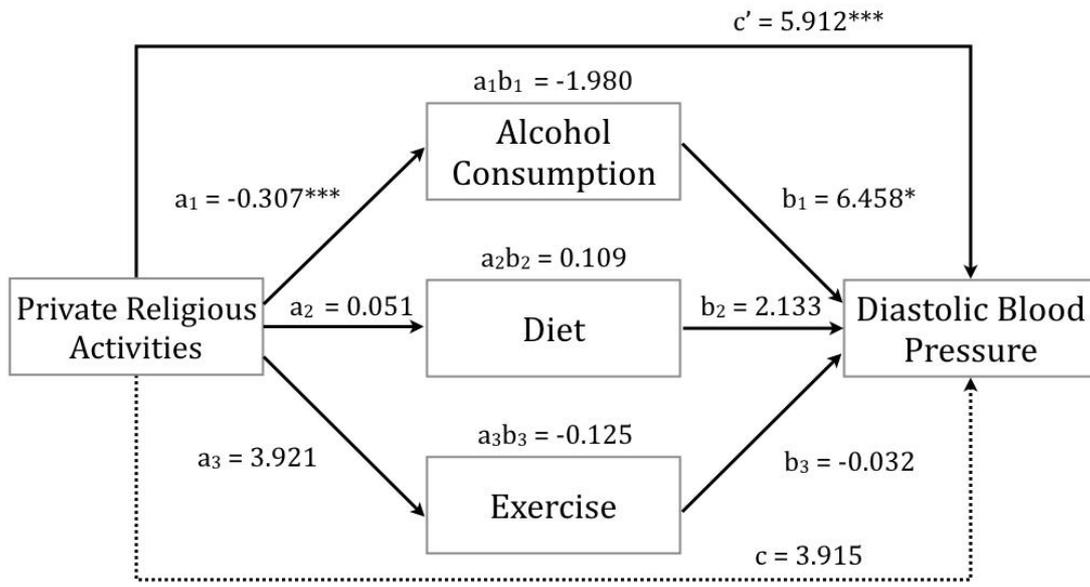
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 12. Effects of religious attendance on diastolic blood pressure.



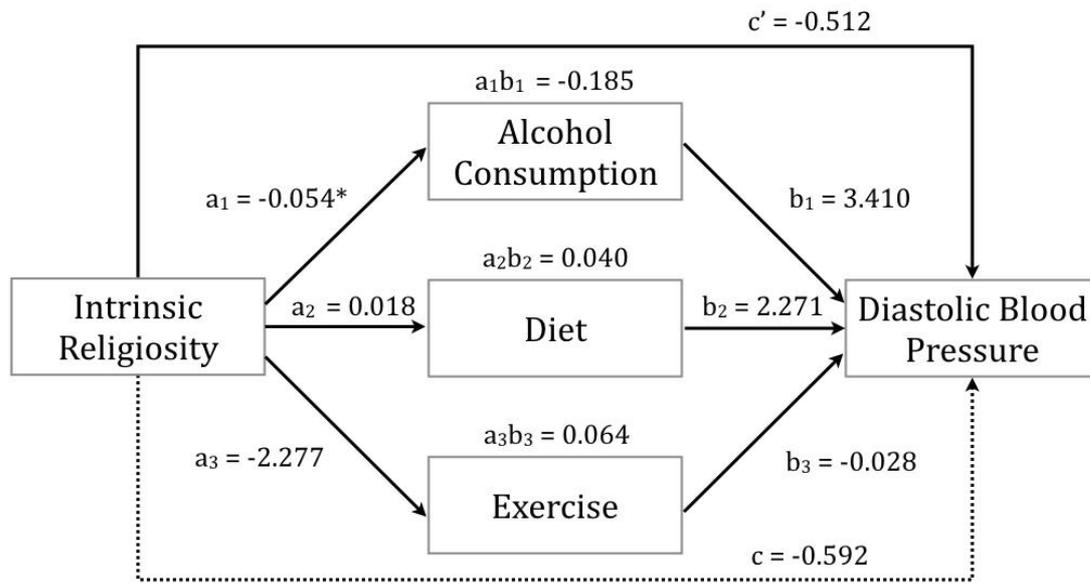
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 13. Effects of private religious activities on diastolic blood pressure.



a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 14. Effects of intrinsic religiosity on diastolic blood pressure.



a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 $*$: $P < 0.05$; $**$: $P < 0.01$; $***$: $P < 0.001$

Figure 15. Effects of Sabbath-keeping on diastolic blood pressure.

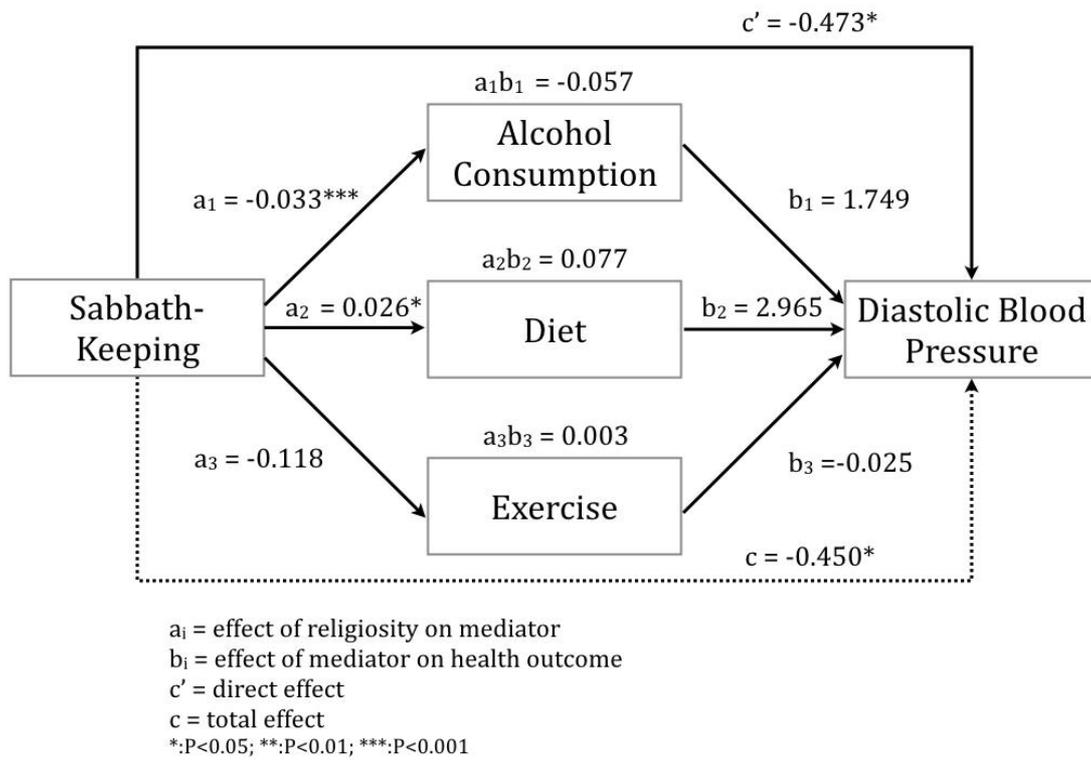
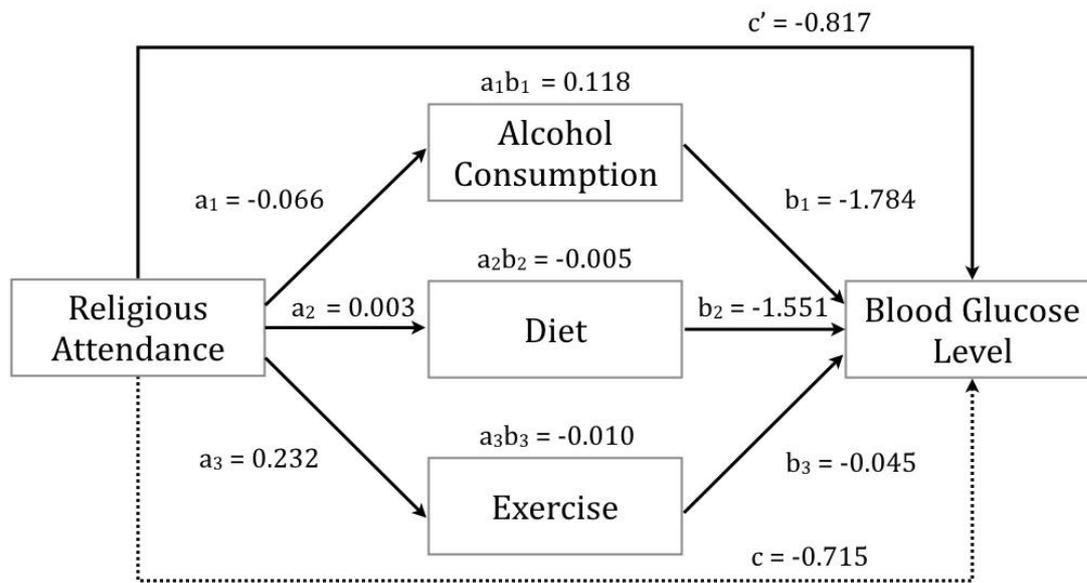
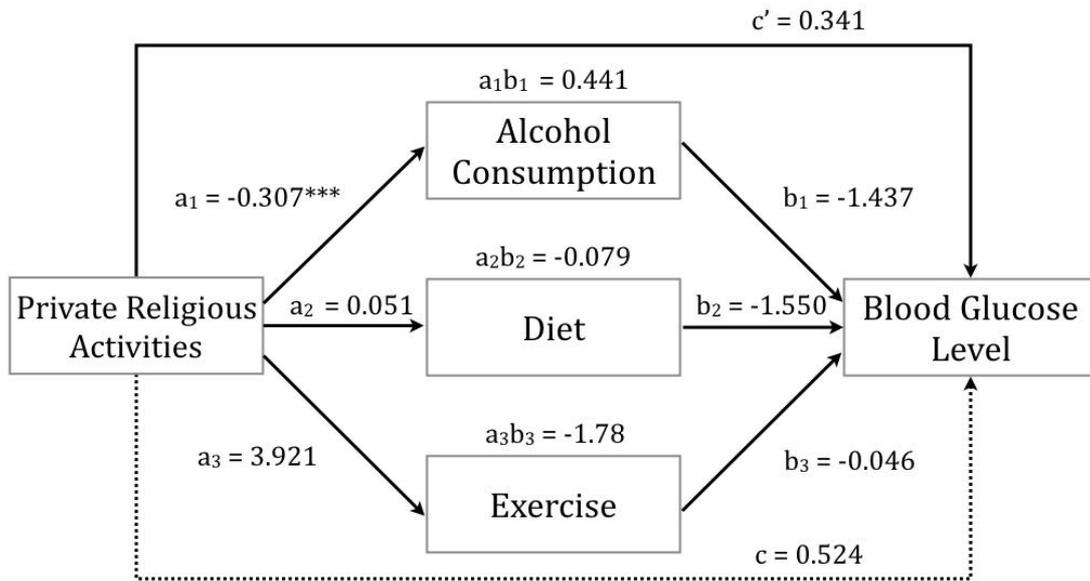


Figure 16. Effects of religious attendance on blood glucose level.



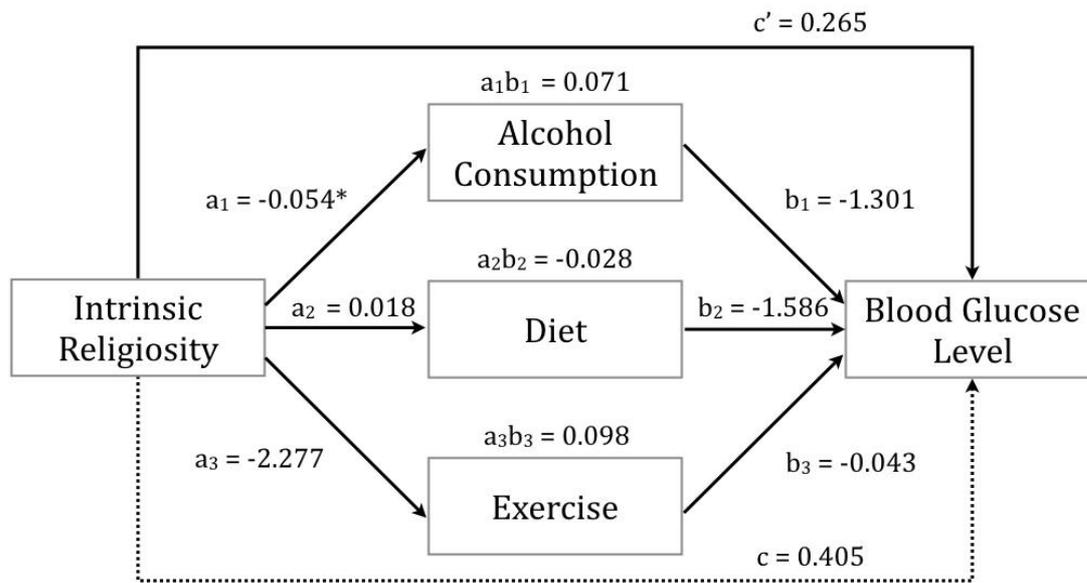
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 17. Effects of private religious activities on blood glucose level.



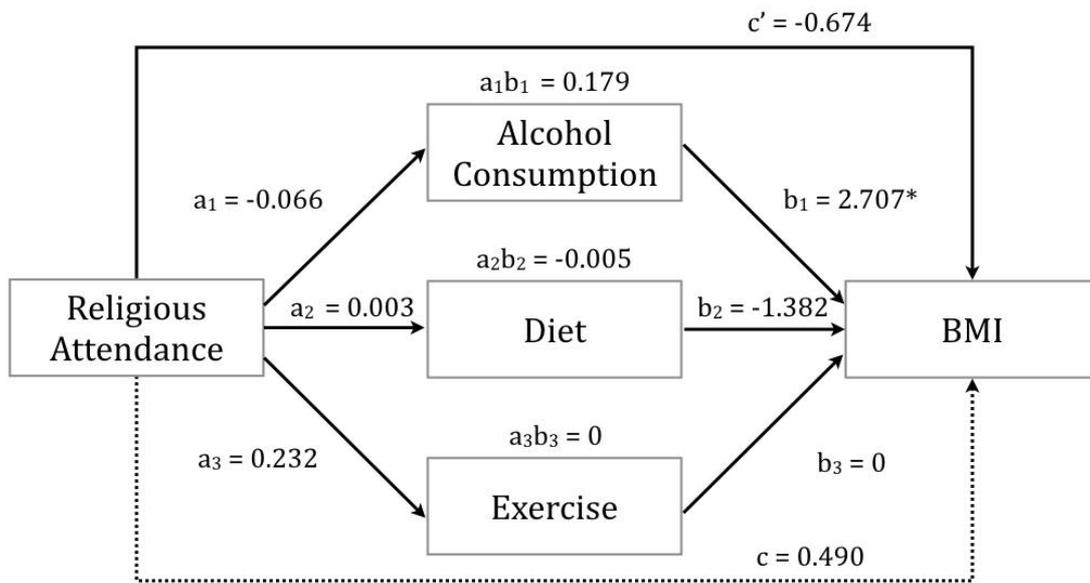
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 18. Effects of intrinsic religiosity on blood glucose level.



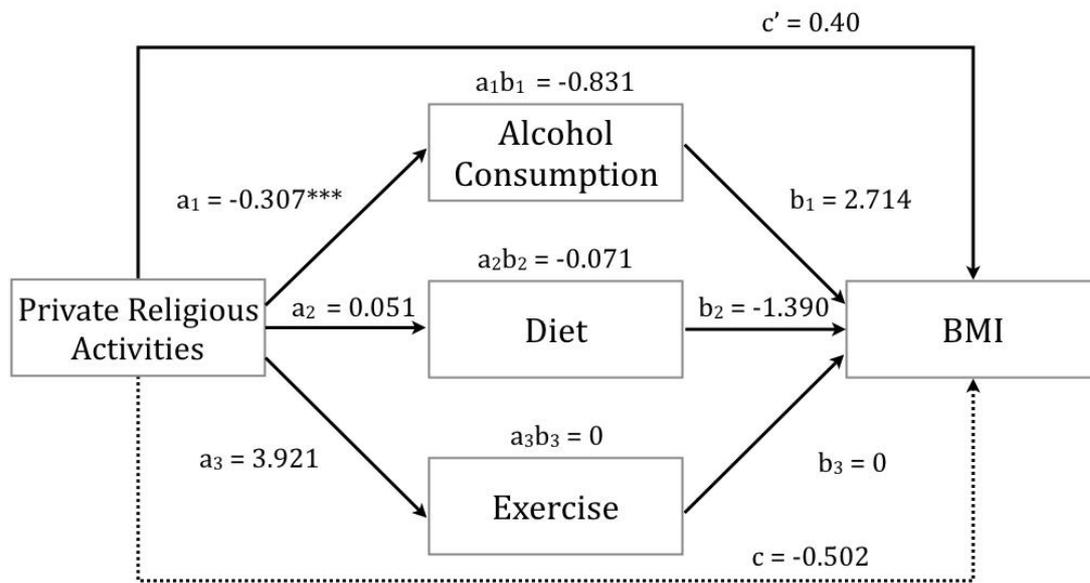
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 19. Effects of religious attendance on BMI.



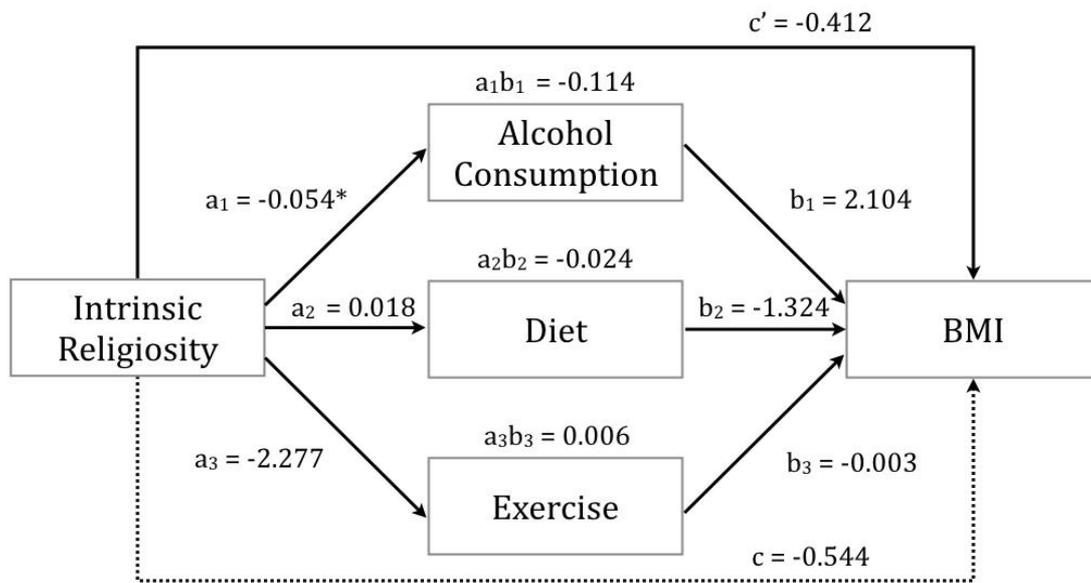
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 20. Effects of private religious activities on BMI.



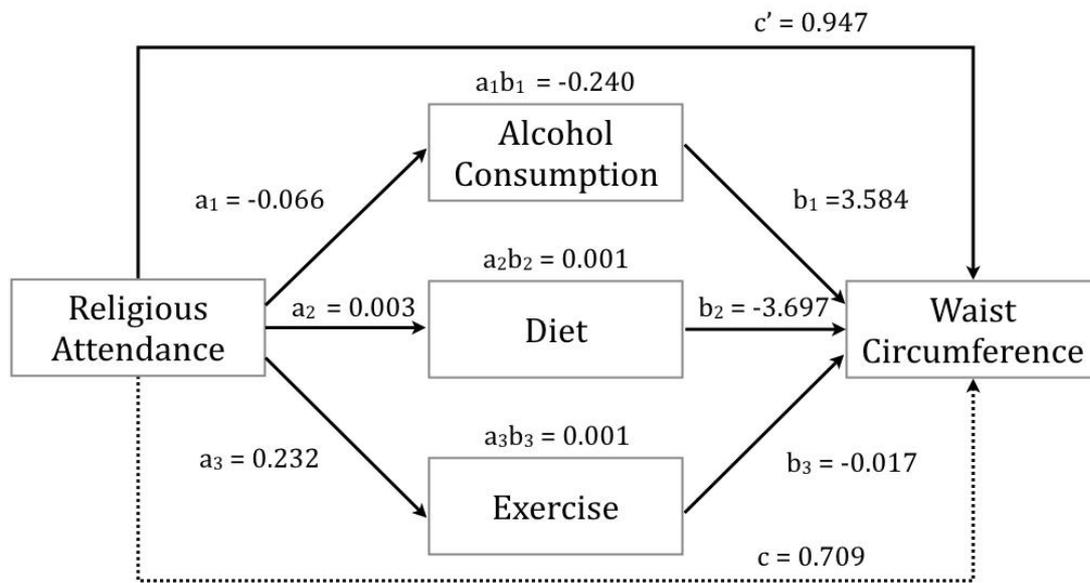
a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 21. Effects of intrinsic religiosity on BMI.



a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 22. Effects of religious attendance on waist circumference.



a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 23. Effects of private religious activities on waist circumference.

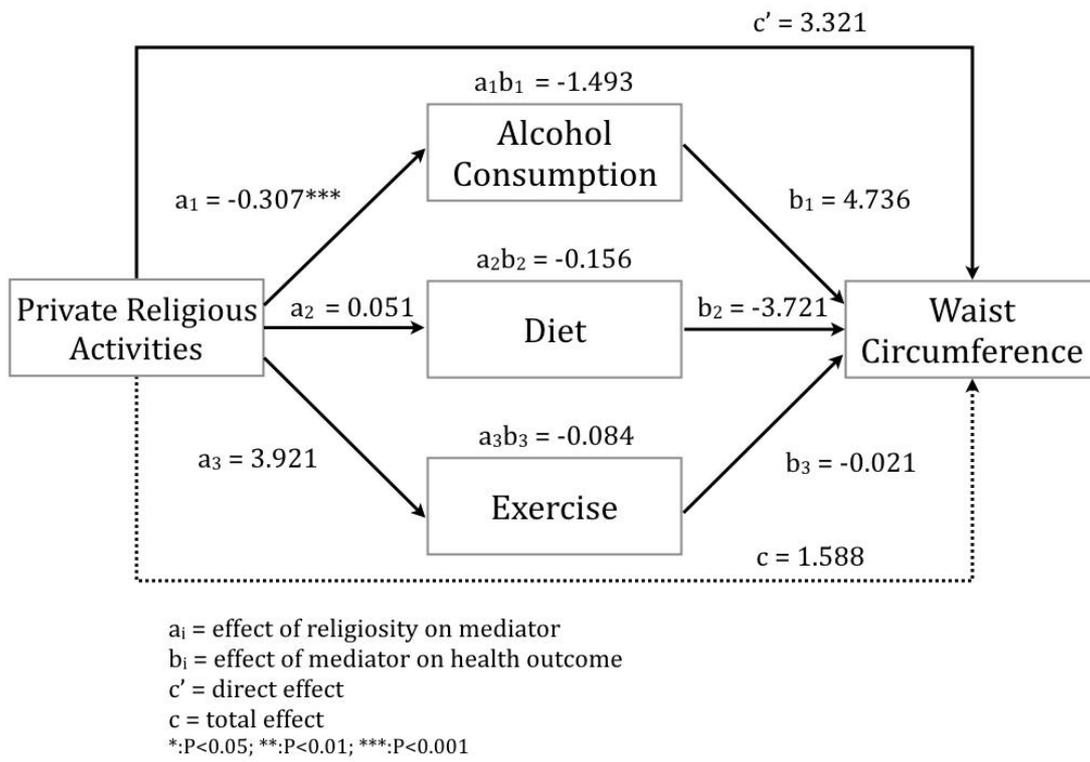
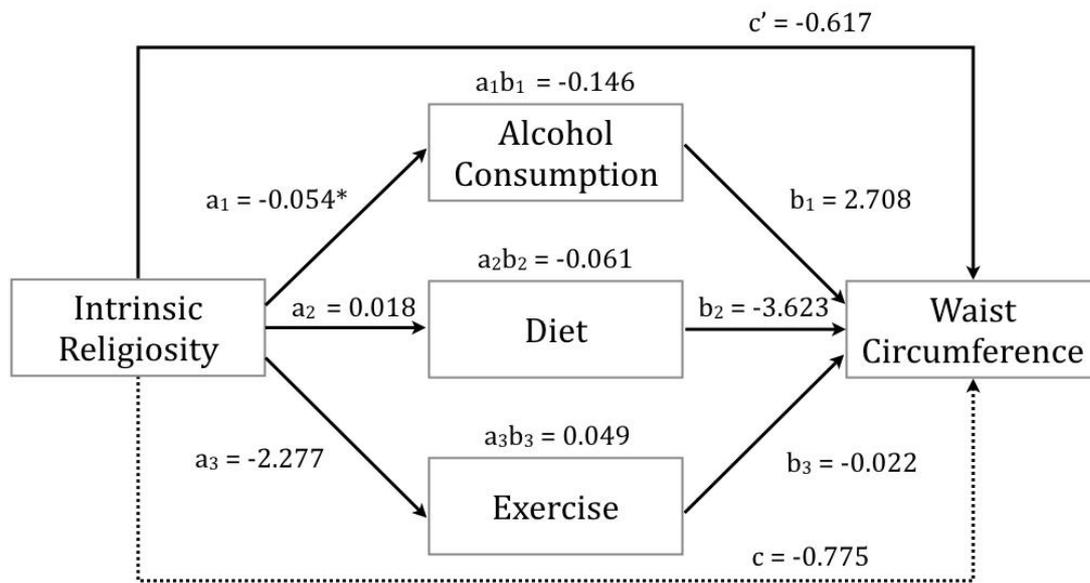
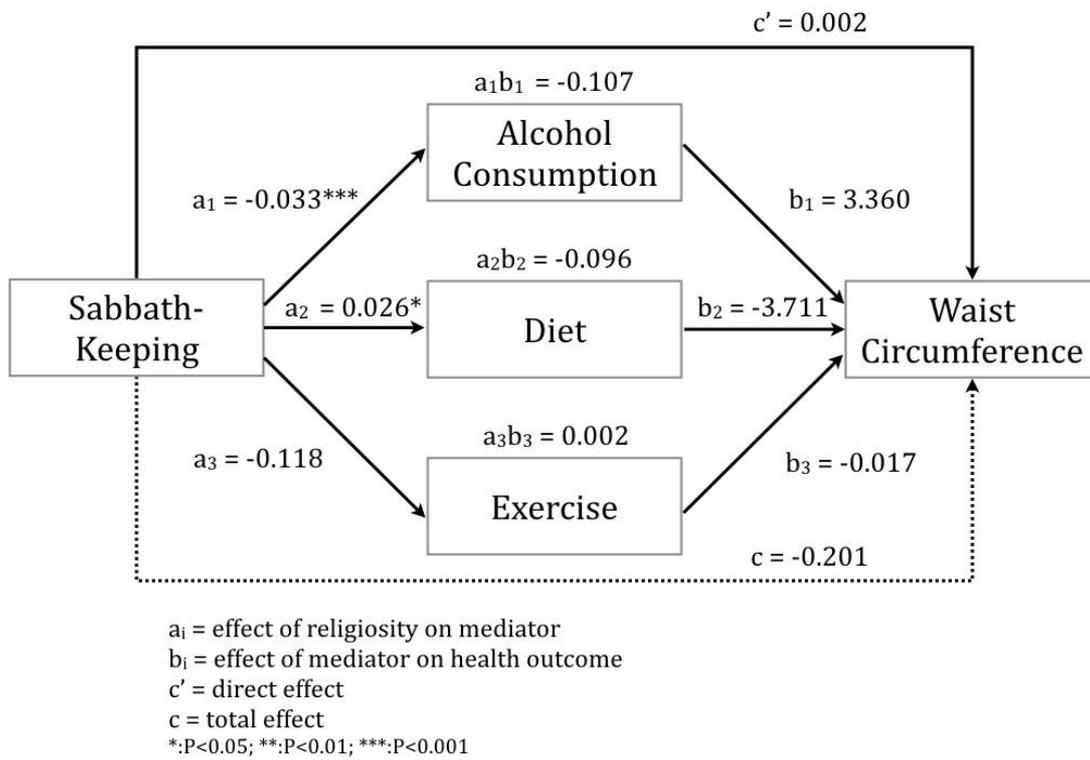


Figure 24. Effects of intrinsic religiosity on waist circumference.



a_i = effect of religiosity on mediator
 b_i = effect of mediator on health outcome
 c' = direct effect
 c = total effect
 *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

Figure 25. Effects of Sabbath-keeping on waist circumference.



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Review

Faith, Food and Fettle: Is Individual and Neighborhood Religiosity/Spirituality Associated with a Better Diet?

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Abstract: Diet is an important contributor to many non-communicable diseases. Religion and spirituality (R/S) has a salutary effect on physical health, and one of the possible links between R/S and positive health outcomes is a better diet. Religious neighborhoods might also play a role in influencing the adoption of a healthier diet. Suggestions for future research in R/S and diet are included.

Keywords: religion; religiosity; spirituality; health; diet

1. Introduction

Research has shown that religion/spirituality (R/S) might have a salutary effect on physical health [1]. Studies have shown a positive association between R/S and lower all-cause mortality [2], and lower risks of cardiovascular diseases [3], cancers [4], and hypertension [5]. One of the possible links between R/S and positive health outcomes is the adoption of religious practices that are also health-promoting [6]. Many religions view the human body as sacred that has to be taken care of carefully, and in many religions there are specific prohibitions against irreverent behaviors which are not only harmful physically but also detrimental to spiritual development. In fact, some evidence has shown that R/S is negatively associated with many harmful behaviors such as smoking,

alcohol and substance abuse [7,8], suggesting that R/S may play a protective role in engaging in health-promoting behaviors.

One of the religious practices that is common in many religions is diet; many religions believe that the food one partakes affects both body and mind, and most religions have specific dietary guidelines regarding what food to eat or avoid. These dietary guidelines fall into two categories: (1) “a temporal abstinence from all or certain foods (fasting)”, e.g., Muslim fasting during Ramadan, Oriental Orthodox Christian fasting before Holy Communion; and (2) “stable and distinctive dietary habits that differ from the general population”, e.g., Muslims consume halal meat, Jews consume Kosher meat [9]. The main purposes of these dietary guidelines are for spiritual advancement rather than health *per se*. However, since these dietary practices are usually long term, they might be influencing the outcomes of diet-related diseases.

Diet plays an important role in maintaining health and is a major contributor to many non-communicable diseases (NCDs). In 2008, about 36 million of the 57 million deaths were due to NCDs, which include cardiovascular diseases, stroke, cancers, diabetes, and chronic respiratory diseases [10]. Four of the NCDs are diet-related and could be easily prevented by adopting a healthy diet. Given the importance of food in religions and diet in the development of NCDs, there is surprisingly scarce research on the relationship between R/S and diet, compared with other areas in R/S and health. Before 1990, there were only seven studies on R/S and diet [11], and between 2000 to 2012 there were only 21 such studies [12].

This paper provides an overview of the research evidence on R/S and diet. The possible role that R/S may play in influencing diet is discussed and the effect of religious neighborhood is considered.

2. An Overview of Research in Religion, Spirituality and Diet

The earlier studies of R/S and diet focused on religious/denominational differences; they compared dietary intake between different religions or different denominations within the same religion. For example, in 1956, a study compared Italian, Jews and other ethnicity of a group of garment workers and found that even though Italians and Jews did not differ in fat intake, Jews consumed more animal fats [13]. A number of studies compared the Seventh-Day Adventists with other denominations or religions or the general population and found that Adventists have a better diet [14,15] (see Groan and Van Der Heid [16]; Shatenstein and Ghadirian [17]; and Sarri, Higgins, and Kafatos [18] for reviews of denominational comparison studies on R/S and diet).

The degree of religiosity and spirituality rather than the actual denomination of religion may be more critical in explaining dietary behaviors. More recent studies on R/S and diet have investigated the level of religiosity/spirituality instead of only comparing denominations or religions. The majority of these studies pointed towards a positive direction, where a higher level of religiosity/spirituality is associated with a better diet [12]. R/S is positively associated with a higher fish intake [3,19], regular breakfast [20] and lower soft drinks consumption among adolescents [21], healthy nutrition [22–24], healthy food choices and eating patterns [25], and less dietary restriction (eating less than two meals a day) [26]. A recent systematic review supported the relationship between R/S and intake of fruit and vegetable and showed that in the majority of the studies a higher level of religiosity or spirituality is associated with a higher intake of fruit and vegetable [27].

A few studies that examined indirectly the relationship between R/S and diet by using other measures also showed a positive association between R/S and diet. In the Third National Health and Nutrition Examination Survey in the U.S. of 3194 elderly, religious attendance was included as one of the five measures of social contact, and it was found that elderly with four or more social contacts have better healthy eating index than those with fewer than four social contacts [28]. In another study, also conducted in the U.S. of 1000 elderly by the University of Alabama at Birmingham, religious attendance was one of the measures of social capital; and among African American men, not attending religious services regularly was associated with higher nutritional risk [29].

By contrast, a small number of R/S and diet studies showed a negative association between R/S and diet. For example, in the 2004 Survey of Texas Adults of 1504 adults, a negative association was found between religious attendance and diet quality, *i.e.*, a monthly religious attendance was associated with reduced odds of sound diet quality [30]. Three R/S and fat intake studies also showed that a higher level of religiosity is associated with higher fat intake [27]. Some studies reported mixed association between different dimensions of R/S and diet, for example, in the study of 3620 African Americans adults aged 28–34 years, those who prayed regularly and placed more importance in religion were more likely to consume fast food, while those who attend religious services more were less likely to consume fast food [31].

Some R/S and diet studies reported no significant relationship between R/S and diet. In a study of 351 Jewish adolescents from a Jewish community in Chicago, self-reported religiosity was not associated with regular breakfast and soft drink and fast food consumption [32]. In a longitudinal study of 351 elderly women from Allegheny County, Pennsylvania, there was no association between level of spirituality and diet [33]. Seven out of the 12 studies on R/S and fat intake showed no significant relationship [27]. A web-based study of 886 Buddhists in the U.S also found no association between Buddhist devoutness and adopting a vegetarian diet [34]. The conflicting results in R/S and diet studies imply that the relationship between R/S and diet might not be straightforward and more careful considerations are needed to understand this relationship.

3. Possible Links between Religion, Spirituality and Diet

As mentioned earlier, in many religions the human body is considered sacred and needs to be taken care of cautiously. In order to keep the body pure spiritually, there are religious guidelines that encourage or prohibit certain behaviors. Whether a religion promotes healthy or unhealthy behaviors depends on the normative practices of that particular religion; if the normative practices are health-promoting then it is likely that the adherents will enjoy a better health.

R/S might encourage a healthier diet because of specific doctrines of a particular religion. The majority of these doctrines deal with the intake of animal flesh. For example, the teaching of Ahimsa (do no harm) in Mahayana Buddhism and Hinduism encourages their adherents to be vegetarians in order to cultivate compassion, since eating animals requires slaughtering and shedding of blood. Non-vegetarian food is considered impure and could hinder one's spiritual development [35]. As a result, these doctrines might help to increase the intake of fruit and vegetable and decrease the intake of animal flesh. In fact, a study has shown that Buddhist monks and nuns, who are vegans, consumed more fruit and vegetable and lesser saturated fat than non-Buddhists [36,37]. The Mormons are

encouraged to eat more fruit and vegetable and to limit their intake of meat. For Catholics, abstinence from meat is a means to overcome gluttony and lust, two of the seven deadly sins [38]. The Seventh-Day Adventists are encouraged to be vegetarians because they believe that the original diet intended by God according to the Bible was vegetarian, and it is part of the religious duty to maintain a healthy body [39]. Even in religions that do not have specific dietary guidelines, for example, the majority of protestant denominations, the teaching that the body is the “temple of the Holy Spirit” (1 Corinthians 6:19–20) might encourage the adoption of a healthier diet.

However, strict dietary practice in certain religions might lead to poor intake of essential nutrients. In a study that compared Hindu and Muslim Indian men, it was found that vegetarian Hindu had a lower circulating concentration of vitamin B₁₂ [40]. Nutritional deficiencies were found in breast-fed infants of mothers who are practicing a strict vegetarian diet because of religious reason [41]. A woman who was on a strict Zen macrobiotic diet for months developed scurvy, and severe folic acid and protein deficiencies [42].

In addition, while R/S is associated positively with a better diet, R/S is also positively associated with overweight/obesity [43–47], which is closely associated with a poor diet [48]. However, it is possible that religious communities are more accepting towards people who are obese rather than R/S causing obesity [44]. The low cigarette smoking prevalence among religious communities might be another reason of a higher prevalence of obesity, since nicotine, found in cigarette, is an appetite suppressor that could contribute to poorer appetite and thus lesser food consumption among the less religious [46]. In fact, one study found that the positive relationship between R/S and greater body weight disappeared after controlling for health behaviors, particularly smoking [46]. Another possible reason is that gluttony is not condemned in certain religions as much as other “sins” and many religious functions involve food, which might be high in saturated fat and refined sugar [49]. The association between R/S and obesity could be related to more sedentary behaviors due to praying, fellowship gatherings with food, and we need to bear in mind that the relationship goes in both directions and there can be moderators (e.g., other health behaviors) which could affect the relationship between R/S and obesity.

4. Religious Neighborhoods and Diet

Neighborhood and health is a relatively new research field which emerged during the late 1980s and early 1990s and has grown exponentially during the last 10–15 years [50]. It has been thought that health is a personal responsibility; an individual’s health is dependent on his or her choices [51]. Indeed, numerous studies have shown that people who adopt a healthy lifestyle enjoy better health and longer lifespan. However, the “personal responsibility” paradigm ignores the social contexts within which people make decisions. There are circumstances when they may be unable to choose a healthy lifestyle. For example, those who live in an area that lacks of resources for exercise are more likely to not exercise [52]. Thus, individual-based explanation of health and illness are insufficient. It is now recognized that an individual’s social environment has an effect on health, illnesses, and health behaviors, hence the increased interest to study neighborhood and its influence on health [53].

Neighborhood characteristics have been found to be associated with dietary quality, for example increased availability and access to a supermarket in a neighborhood was positively related to healthier

diet and a lower risk of obesity; an increased availability of healthy food in supermarket was associated with a healthy diet [54]; and the presence of more fast food restaurant was associated with poorer diet [55]. Neighborhood and obesity studies also showed similar association between neighborhood and dietary qualities. Higher perceived neighborhood disorder is associated with poorer self-rated overall diet quality [56] and poor dietary quality in children [57]. These results indicate that neighborhood may play an important role in shaping dietary behaviors.

Even though religion is practiced individually, it is also a community activity, and each religious community is a miniature neighborhood by itself where adherents of the same faith gather regularly and interact with each other. Similar to other neighborhoods, different religious communities also vary in demographical mix such as socioeconomic status (SES), racial proportions, education *etc.* In addition, there is a variation in the degree of adherence to religious norms in different religious communities even within the same religion. Thus, as in other neighborhoods, the physical and social characteristics of a religious community might influence the health and health behaviors of its members. In one study, Israeli Jewish men and women living in more religiously affiliated neighborhood have a lower mortality than that of secular neighborhood, even after controlling for SES, age, country of origin, marital status, and education [58].

The religious neighborhood one belongs to might encourage or discourage healthy diet. There could be doctrinal differences regarding healthy eating in different religious neighborhoods. For example, healthy eating is part of the doctrine of the Seventh-day Adventist Church, and believers are encouraged to consume more fruit and vegetable and if possible, to be vegetarians. In fact, research has shown that Adventists consumed more fruit and vegetable compared with the Methodists [15] and Catholics [14].

However, even within a denomination, different congregations might have different level of adherence to their doctrine, and hence exhibit different congregational level of observance of dietary practices. A less adherent believer who is attending a more adherent congregation might practice a healthier diet because of more exposure to health messages. In a study that examined health and wellness activities in faith-based organizations, it was found that faith leaders' and congregational characteristics are associated with the number of health and wellness activities; a congregation that is large, located in urban areas, and have faith leaders who are physically active and consume more fruit and vegetable tend to have more health and wellness activities [59]. It is possible that a more adherent congregation might organize more health and wellness activities, which have been shown to be effective in promoting healthy diet [60]. In addition, a less adherent believer might see his or her faith leader as a role model and might experience social pressure from the congregation to conform to the diet of the more adherent congregation. The more health-conscious faith leaders are also more likely to promote health through sermons, health-promoting literature, and health information on notice boards.

On the other hand, when a more adherent believer attends a congregation that does not practice healthy diet, he or she might not be encouraged to adopt a healthy diet because a less observing congregation is less likely to promote healthy diet and serve healthy food during church functions. There is also less social pressure to conform to healthy diet and no role model to look up to.

5. Suggestion for Future Research

R/S is experienced differently in different groups of people: Africans in the U.S tend to be more religiously active than Whites [61]; females are more religious than males [62]; and older people are more religious than younger people [63]. Thus, R/S might influence health and health behaviors differently in different gender, age and ethnic groups. For example, overall African Americans have poorer health than the Whites; however, African Americans who are more religious have better health than African Americans who are less religious, and this correlation is not as strong as in Whites [47,64,65]. However, most of the previous studies on R/S and diet included samples from the U.S. and other Western countries, with only a handful of studies from Asia and Africa. It is unknown whether Asians and Africans, whose diets are different from those of Westerners, experience similar health benefits from R/S to people from Western countries, and whether there are any differences by gender and ethnic groups in Asia and Africa.

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A wide range of dietary assessments were used in the studies of R/S and diet, and the most common are scales that provide an overall dietary score. Dietary record, where the respondent records the amount of food and drinks consumed within a time frame, is considered the “golden standard” of dietary assessment method [67]. However, most of the R/S and diet studies did not use dietary records to measure dietary intake. Dietary scales, even though they are convenient to use, do not provide specific dietary intake. Thus, future studies in the area should consider using dietary record, such as the 24-hour dietary recall, in addition to other dietary assessment methods.

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denomination has different teaching about diet, thus a single-denominational study eliminates the need to control for denominational differences [68].

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6. Conclusions

Religion is considered important by many people around the world. One recent survey estimated that 51% of the population in the world believe in god(s) [71]. Another survey conducted in 143 countries showed that the majority of people, especially those from Africa and Asia, held that religion is an important part of their lives [72]. It is possible that people who consider religion important will also follow the dietary guidelines of their religion and the long-term dietary practice required by certain religions might, in turn, influence the outcomes of diet-related diseases. For example, compared with non-Adventists, Adventists enjoyed a longer lifespan [73], lower risks of cancers and coronary heart diseases, lower all-cause and cancer mortality [74], and lower cardiovascular mortality [75]. Globally, low fruit and vegetable intake contributed to about 1.7 million NCD deaths a year [76]. Religions that encourage the consumption of fruit and vegetable might help to prevent NCD deaths.

Many methods have been used to reduce diet-related diseases, such as policy change and legislation, e.g., increasing taxes on unhealthy ingredients. However, R/S has not been explored more extensively for its potential to reduce diet-related diseases. Many faith-based health promotion projects have been conducted successfully in African churches in the U.S. [77–79], and it is unknown whether similar results could also be obtained in other populations. Given the importance of religion, especially among people from Africa and Asia, and the rise of NCDs in these developing regions [10,80], studies related to R/S and diet could help explore whether R/S could be one of the potential channels to promote healthy eating in addition to those that already exist.

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Author Contributions

All authors contributed to the work reported in this paper. Min-Min Tan conducted literature search and wrote the paper; Daniel D. Reidpath and Carina K.Y. Chan participated in drafting and revising the manuscript. All authors read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Author Contributions

All authors contributed to the work reported in this paper. Min-Min Tan conducted literature search and wrote the paper; Daniel D. Reidpath and Carina K.Y. Chan participated in drafting and revising the manuscript. All authors read and approved the final version of the manuscript.

Conflicts of Interest

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O.2. Multilevel regression paper

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Communities of faith and health eating – A multilevel study of Seventh-Day Adventist congregations in Malaysia

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Conflict of Interest:

Min Min Tan declares that she has no conflict of interest.

Carina K.Y. Chan declares that she has no conflict of interest.

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Abstract

Neighbourhood characteristics have an effect on the health above and beyond the effect of the individual characteristics of those living in the neighbourhood. Neighbourhood might affect the health of its residents by influencing the adoption and maintenance of health behaviours. Religion is a community activity and religious congregation could be considered a community of faith and similar to neighbourhoods. Thus, the characteristics of a religious congregation might influence the health behaviour and health of the congregants. The purpose of this study was to examine whether congregational size and religious conservativeness would be significantly associated with the quality of members' diets even after taking account of their demographics and individual levels of religiosity. Data from survey of 574 Seventh-Day Adventists of 41 congregations in West Malaysia were analysed using multilevel linear regression. Congregational conservativeness predicted individual dietary habit above and beyond individual characteristics; a higher congregational conservativeness was positively associated with better individual dietary habit scores. Congregational size was not significantly associated with dietary habit. Individuals from more conservative congregations had better dietary habit; they might be exposed more to health promotion activities and receive more social support to practice healthy eating. They might feel the social pressure to conform to a healthier diet. All the Adventist congregations in West Malaysia are small and the effect of congregational size might not be sufficiently strong to influence the dietary habit of the congregants.

The finding supports the role of religious congregations as a potential channel to promote health by encouraging the congregants to adopt a healthy diet.

Introduction

It is well established that Seventh-Day Adventists (SDAs) in the United States live healthier life styles and enjoy healthier diets than non-SDA (Fraser & Shavlik, 2001; Phillips et al., 1980). Members of the church tend to consume diets richer in fruit and vegetables, and the majority are exclusively vegetarian (Alexander et al., 1999; Kent & Worsley, 2009; Kuczmarski et al., 1994; Sabate et al., 1990). The increased consumption of fruit and vegetables does not simply express a food preference. It is an article of faith among this group of Christians that one should maintain a healthy diet; and members of the Church are encouraged towards vegetarianism. As a consequence of the healthier lifestyle and diet, SDAs also have a greater life expectancy than non-SDAs, with lower rates of cancers and cardiovascular diseases (Phillips et al., 1980)

A recent cross-sectional study of SDAs in West Malaysia, the first study of SDA dietary practice outside North America and Europe, found an association between religiosity and diet (Tan et al., 2016). That is, there was a significant relationship between individual levels of religiosity and better dietary habits as well as higher rates of vegetarianism.

One aspect of the relationship between religiosity and dietary practice that has not been examined before is whether it is individual levels of faith that are associated with dietary practice or whether there are effects that operate at the level of the community of faith, that is, the congregation, above and beyond individual religiosity.

In the social epidemiology literature there are many examples of community or neighbourhood level factors associated with health behaviours and health outcomes (Ellison, 1991; Helm et al., 2000; H. G. Koenig et al., 1998). Neighbourhood is “generally defined as a specific geographic area and functionally as a set of social networks where face-to-face social interaction occur” (Hunter & Riger, 1986; Schuck & Rosenbaum, 2000). A number of studies have shown that neighbourhood characteristics have an effect on the physical and mental health of the people living in the neighbourhood beyond the characteristics of the individuals within the neighbourhood (Diehr et al., 1993b; Diez Roux & Mair, 2010; Pickett & Pearl, 2001). There is a strong association, for instance, between neighbourhood level poverty and mortality (Anderson et al., 1997; Haan et al., 1987) and exposure to neighbourhood violence is significantly associated with reported distress symptoms among children (Martinez & Richters, 1993).

Neighbourhood might affect the health of its residents by influencing the adoption and maintenance of health behaviours (Diehr et al., 1993a). People living in more deprived areas are more likely to smoke daily and less likely to exercise (Sundquist et al., 1999). In neighbourhoods with resources for physical activity, there is a higher prevalence of physical activity and a lower risk of obesity (Papas et al., 2007). Neighbourhood characteristics are also associated with the diet of its residents. In communities where there are more fast food restaurants the residents have poorer diet (Moore et al., 2009). In contrast, an increased availability of and access to supermarkets is associated with a healthier diet and a lower risk of obesity among the residents (Larson et al., 2009). Higher perceived

neighborhood disorder is also associated with poorer self-rated overall diet quality (Burdette & Hill, 2008) and poor dietary quality in children (Keita et al., 2011).

Religion, in addition to being an individual practice, is also a community activity, where the adherents gather together regularly at a specific geographic location and interact with each other face-to-face. Thus, a religious congregation could be considered a community of faith and similar to neighbourhoods in so far as different congregations within the same Church may vary in characteristics such as size and religious conservatism.

In the religious studies literature there are a number of multilevel studies that simultaneously took account of individual characteristics such as religiosity and the factors operating at the level of the community of faith or congregation, notably in the area of social justice (Houston & Todd, 2013; Todd & Allen, 2011). To our knowledge, however, no study has looked at the multilevel relationship between individual and congregational factors and health-related outcomes. We hypothesised that in a multilevel analysis of Adventist church members, congregational factors such as the size of the congregation and the religious conservativeness of the congregation would be significantly associated with the quality of members' diets even after taking account of individual church members' levels of religiosity.

Methods

The participants of this study were baptized Seventh-Day Adventists who were above 18 years old and were residing in West Malaysia recruited through the pastors of the congregations. The participants filled in a questionnaire that contained items about religiosity and socio-demographics whereas the pastors filled in a questionnaire that contained items about congregational characteristics. See Tan et al. (2016) for additional details of the study.

Measures Outcome

Dietary habit was measured by using the Nutrition subscale of Health Promotion Lifestyle Profile II (HPLPII). The Nutrition subscale contains nine items that assess various aspects of dietary habit such as choosing a low-fat, low-salt and low-sugar diet, regular consumption of fruit and vegetable, eating breakfast etc. The items are scored on a 4-point response scale (never, sometimes, often, routinely), and a higher score indicates a higher frequency. A total score for the subscale was obtained by calculating the mean of the responses to the nine items (Walker et al., 1995). The internal consistency of the scale in the present study was 0.71.

Individual Characteristics

The participants were asked about their age, gender, ethnicity, marital status, employment status, income, level of education, age of conversion/baptism, and whether they were born into an Adventist family. Age and age of conversion/baptism were measured in years and centered through grand-mean centering. Employment status has five categories: employed, unemployed, retired,

homemaker and student. For statistical analysis, the last four categories (unemployed, retired, homemaker and student) were combined as one category (unemployed). Monthly household income of the participants was categorized as less than RM1000 (USD257), RM1001-2999 (USD257-771), RM3000-4999 (USD771-1285), and RM5000 (USD1285) and above. Highest education level of participants was categorized as secondary school or less, diploma (a higher education qualification just below a bachelor's degree), and bachelor's degree or above. t-test and chi-square were conducted to determine whether there is gender differences in the demographic and religious variables.

Intrinsic religiosity was measured using the three-item intrinsic religiosity subscale from the Duke University Religion Index (H. Koenig & Bussing, 2010). It is scored on a 6-point response from *Definitely true of me* to *Definitely not true*. The scores were reversed coded so that a higher score indicates a higher intrinsic religiosity. The internal consistency (Cronbach's alpha) of the scale in the present study was 0.60. This is discussed further in study limitations.

The Adventist Church encourages its members to keep the Sabbath by not engaging in secular activities during the Sabbath (from Friday sunset to Saturday sunset). Sabbath keeping was measured using the Secular Activities on Sabbath subscale, one of the subscales of the Sabbath-Keeping Scale (Lee et al., 2006, April). The Secular Activities on Sabbath measures how much a participant engages in secular activities such as shopping, reading secular magazines, attending secular concert or watching movie, and watching or listening to news programs. It is scored on a 6-point response scale from *every Sabbath* to *never*. The scores of this subscale were reversed coded so that a higher score represent

better Sabbath keeping. The internal consistency of the scale in this study was 0.80.

Congregational Characteristics

The pastor of each congregation was asked about the average attendance of the congregation during the previous quarter and the conservativeness of their congregations, which was measured on a 10-point scale, where a higher score indicated greater conservativeness.

Analysis

Multilevel modeling was used to examine how individual religiosity and congregational characteristics were associated with individual dietary habits while controlling for individual demographics. Four nested models were developed. The null model, Model 0, was used to establish whether there was a significant congregational clustering of dietary habits. Models 1 and 2 examined individual (level 1) variables, while Model 3 added congregational (level 2) variables. In Model 1, the relationship between dietary habit and demographic were examined. Model 2 added two religiosity variables, intrinsic religiosity and Sabbath-Keeping and Model 3 added congregational conservativeness and size. The models were fitted using maximum likelihood estimation. Fit indices (AIC, and $-2 \log$ likelihood) and intra-class correlation coefficients were computed. To compare models, chi-square tests of $-2 \log$ likelihood were conducted. The data were analyzed with *nlme* package in the R statistical environment (Pinheiro et al.; R Core Team, 2015).

About 10% of the cases included some missing data. Multiple imputation was conducted to overcome this. Multiple imputation is a statistical technique to impute incomplete data and has been shown to reduce bias and increase efficiency compared to listwise deletion (Honaker et al., 2011). Unlike some other procedures for handling missing data, multiple imputation does not assume that the data are completely missing at random (Tabachnick & Fidell, 2013). Five imputed datasets were obtained and each dataset was analyzed separately and their results were pooled according to Rubin's rule (Rubin, 2004).

Results

Five hundred and seventy-four questionnaires from 41 Adventist congregations in West Malaysia were available for analysis. Table 1 is a summary of the demographics of the participants. The average age of the sample was 34.6 years, while the average age of baptism (joining the Seventh-Day Adventist Church) was 19.4 years. About half of the participants were Chinese, and a quarter were indigenous Malaysians. About 44 percent of the participants were male and about 62 percent of the sample had completed tertiary education, and 40 percent were currently married. Sixty per cent of the participants were employed. About 45 percent of them were born and raised by parent(s) who are Seventh-Day Adventists. There were no significant differences between males and females, except dietary habits and Sabbath-keeping, where females scored higher than the males.

[TABLE 1 ABOUT HERE]

Pastors from 41 congregations returned the questionnaires on congregational characteristics. Four of the 41 congregations had only one participant. However, they were still included in the multilevel analysis because “they can still provide partial information that allows estimation of the coefficients and variance parameters of the individual- and group-level regressions” (Gelman & Hill, 2006, p. 275). The average congregational size is 62 regular attendees. The largest congregation had about 200 regular attendees while the smallest congregation had about 15 regular attendees. The average congregational conservativeness rating by local pastors was 6.2.

To determine how much of the variance in dietary habits can be explained at the congregational level, the intra-class correlation (ICC) was computed from the variance components of the null model, i.e. the model containing no independent variables. About 7.6 percent of the variance in dietary habits can be explained by congregational level. Table 2 summarizes the three multilevel modeling results of individual and congregational variables on dietary habits. Model 1 includes individual level demographic variables only. Only a few of these were significantly associated with dietary habit. Model 1 shows that age, being a female, having a Bachelor’s degree and being born in an Adventist family were positively associated with dietary habits score, while age of baptism is negatively associated with dietary habit.

In Model 2, individual religious variables were added. Both intrinsic religiosity and Sabbath keeping were positively and significantly associated with dietary habit. In Model 3, two congregational variables, size of congregation and congregational conservativeness, were added. Only congregational

conservativeness was positively and significantly associated with dietary habit. The addition of the congregational variables in Model 3 improved the fit indexes over and above the addition of the individual religious variables in Model 2. All the previously significant demographic variables remained significant in Models 2 and 3, with the addition of significant positive association between having a diploma and having a household income of more than RM5000 per month and dietary habits in Model 3.

[TABLE 2 ABOUT HERE]

Discussions

There has been considerable research showing the effects of neighborhoods on health (Cummins et al., 2005; Parkes & Kearns, 2006; Stafford & Marmot, 2003), and a small amount of research looking at religious congregations as “neighborhoods” that affect social values (Houston & Todd, 2013; Todd & Allen, 2011). There has, until now, however been no research looking at the effect of congregations on health outcomes. The current study showed that congregational characteristics were significantly associated with individual dietary habits above and beyond any association with individual characteristics.

At the individual level, the current study showed that age, sex (being female), level of education, and greater personal religiosity were all positively associated with better dietary habit score. This is consistent with previous studies which showed that females have healthier food choice than males (Baker & Wardle, 2003; Wardle et al., 2004). Older females also consume more fruit and vegetable (Liu et al., 2000). People who are more educated also have healthier diet (Johansson et al., 1999; Murakami et al., 2009; Shimakawa et al., 1994). A higher level of religiosity is associated with regular breakfast (John M. Wallace & Forman, 1998) and lower soft drinks consumption (Pitel et al., 2012) among adolescents, healthful nutrition (Chliaoutakis et al., 2002; Homan, 2010; Reid & Smalls, 2004), healthy food choices and eating patterns (Rew et al., 2007).

At the congregational level, greater congregational conservativeness was positively associated with better individual dietary habit scores, whereas congregational size was not significantly associated with dietary habit. Given the

data, we can only speculate about the nature of the relationship between congregational conservativeness and individual dietary habit. One possible reason an individual attending a more conservative church is more likely to practice healthy eating than an equivalent individual attending a less conservative church relates to the intensity of exposure to health related messages. Given the doctrinal centrality of health and diet to SDA teachings, more conservative church might have more health-related sermons and seminars, and more health literature being distributed, and displayed within the church. This would be consistent with one recent study which found that higher perceived church support for healthy eating through spoken and written information within the church was positively associated with higher fruit and vegetable intake and low-fat dietary consumption (Baruth et al., 2011).

The conservativeness of a congregation, one might imagine, would be influenced by the conservativeness of the faith leader of the congregation. Presuming doctrinally more conservative SDA pastors are more likely to adhere to the central teaching around healthy diet and healthy behavior this could then influence the entire congregation. This would be consistent with a study by Bopp & Fallon (2011), when they found that congregations with faith leaders' who were more physically active and consumed more fruit and vegetables also tended to engage in more health and wellness activities (Bopp & Fallon, 2011).

In addition, there may be effects of social conformity on dietary choices (Mollen et al., 2013). Aggregating individual choices may create a norm within the congregation towards more or less healthy diets. Within doctrinally conservative congregations this would have the effect of creating a social support structure to

practice healthy eating. Religion also predicts conformity for a number of social norms (Welch et al., 2006), and the less adherent individual attending a more conservative congregation might feel the social pressure to conform to the diet of other members of the congregation. In addition, a more conservative congregation might be more explicit regarding its doctrinal teaching about diet and thus providing clear guidelines for the congregation to follow. One study, for instance found that a higher cohesion within a congregation resulted in more formal and more explicit rules are positively associated with higher fruit and vegetable intake and lower fat intake (Hart et al., 2007).

The study does have a number of limitations that should be kept in mind. The data are cross-sectional and it is difficult to be clear about the causal relationships. Longitudinal studies following individuals prior to formal conversion to the Adventist church may elucidate the relationship better. The responses to questionnaires were also self-reported and might be affected by recall or social desirability biases. The latter bias may reflect the apparent congregational effect, rather than a truly healthier diet. That is, members of more conservative congregations may be more likely to report diets that are more doctrinally consistent. Finally, only a simple measure of congregational conservativeness was used, and this could benefit from additional refinement. The current study was of only one religious congregation in Malaysia, and the results should not be generalised to other denominations where diet was not so centrally important. Nonetheless, the results do point to the potential role of religious communities in health promotion, particularly where the health promotion message and the doctrinal message are consonant.

Table 28. Demographics

Variables	All	Males (n=253)	Females (n=321)
Age (years)	34.6±13.70	35.31±14.42	34.0±13.09
Ethnicity			
Chinese	54.0%	51.5%	56.0%
Indian	9.4%	10.4%	8.6%
Indigenous	25.5%	24.0%	26.6%
Others	11.2%	14.2%	8.8%
Education			
Secondary school or less	37.1%	35.8%	38.1%
Diploma [†]	25.7%	22.9%	28.0%
Bachelor's degree	30.0%	33.1%	27.6%
Graduate degree	7.1%	8.2%	6.3%
Marital status			
Never married	52.4%	54.8%	50.6%
Currently married	41.4%	42.5%	40.6%
Previously married	6.1%	2.7%	8.8%
Income ^{††}			
Less than RM1000	23.5%	23.6%	23.5%
RM1001-2999	35.6%	30.9%	39.4%
RM3000-4999	23.2%	22.6%	23.6%
Above RM5000	17.7%	22.9%	13.5%
Employment (Yes)	60.0%	65.6%	55.6%
Age of baptism (yrs)	19.4±10.08	19.6±10.36	19.2±8.86
Born in Adventist family (Yes)	45.7%	46.2%	45.3%
Intrinsic religiosity (3 = low, 15 = high)	14.0±1.52	4.0±1.51	14.1±1.53
Sabbath-keeping (4 = low, 24 = high)*	20.8±3.86	20.4±4.15	21.1±3.59
Dietary habit (1= never, 4 = routinely) ^{***}	2.7±0.48	2.7±0.44	2.8±0.50

Significant differences by gender: *, p<0.05; **, p<0.01; ***, p<0.001

[†] A higher education qualification just below a bachelor's degree

^{††} Income categories and their USD equivalent: Less than RM1000 =USD257, RM1001-2999=USD257-771, RM3000-4999=USD771-1285, and RM5000 and above=USD1285 and above

Table 2. Multilevel linear modeling of dietary habits

Variables	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
<i>Level 1 (individual)</i>						
Intercept	2.51***	0.08	1.71***	0.21	1.49***	0.23
Age	0.11***	0.03	0.09**	0.03	0.09**	0.03
Gender						
Male						
Female	0.13***	0.04	0.12**	0.04	0.11**	0.04
Ethnicity						
Chinese						
Indian	-0.10	0.08	-0.11	0.08	-0.10	0.07
Indigenous	0.08	0.06	0.07	0.06	0.10	0.06
Others	-0.08	0.07	-0.08	0.07	-0.05	0.07
Marital status						
Umarried						
Currently married	-0.02	0.06	-0.01	0.06	0.00	0.06
Previously married	0.06	0.09	0.08	0.09	0.09	0.09
Education						
Secondary school or less						
Diploma [†]	0.08	0.05	0.09	0.05	0.10*	0.05
Bachelor's degree	0.10*	0.05	0.10*	0.05	0.11**	0.05
Graduate degree	0.11	0.08	0.09	0.08	0.09	0.08
Income ^{††}						
Less than RM1000						
RM1001-2999	-0.04	0.06	-0.03	0.05	-0.02	0.05

RM3000-4999	0.06	0.06	0.07	0.06	0.08	0.06
Above RM5000	0.13	0.07	0.13	0.07	0.14*	0.07
Occupation	0.05	0.05	0.04	0.04	0.05	0.04
Employed						
Unemployed						
Age of baptism	-0.09***	0.02	-0.08***	0.02	-0.08**	0.02
Born in Adventist family						
No						
Yes	0.09*	0.05	0.10*	0.05	0.10*	0.05
Intrinsic religiosity			0.04**	0.01	0.04**	0.01
Sabbath-keeping			0.01**	0.01	0.01*	0.01
<i>Level 2 (Congregational)</i>						
Size of congregation					0.00	0.00
Conservativeness					0.03*	0.01
<i>Variance components</i>						
	σ^2	SD	σ^2	SD	σ^2	SD
Congregation	0.013	0.113	0.012	0.110	0.008	0.090
Residual	0.187	0.433	0.181	0.436	0.181	0.426
<i>Fit indices</i>						
AIC	729.5		714.0		712.1	
-2 Log likelihood	691.5		672.0		665.1	
<i>Model Comparison</i>						
	With null model		With Model 1		With Model 2	
Chi-square (df)	72.2(16)***		19.5(2)***		6.9(2)*	

*:P<0.05; **:P<0.01; ***:P<0.001

σ^2 - variance; SD - standard deviation; AIC - Akaike information criterion

† A higher education qualification just below a bachelor's degree

†† Income categories and their USD equivalent: Less than RM1000 =USD257, RM1001-2999=USD257-771, RM3000-4999=USD771-1285, and RM5000 and above=USD1285 and above

Compliance with Ethical Standard

Conflict of interest. None

Ethical approval. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent. Informed consent was obtained from all individual participants included in the study.

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