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Physical Activity and Sedentary Behaviour in Occupational Groups from Papua New Guinea: Self-reported Patterns and Correlates

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ABSTRACT

Background

Rapid economic growth and urbanisation in developing countries has led to changes in lifestyle behaviours and contributed to the risk of developing non-communicable diseases such as heart conditions, type 2 diabetes, obesity and cancer. Decreases in occupational physical activity (PA) and sedentary behaviour (SB) are of particular concern. Whereas the evidence base for PA and SB in workers from developed countries is extensive, fewer studies have investigated PA and SB issues in occupational groups from developing countries such as Papua New Guinea (PNG), in the Pacific region currently experiencing major economic change.

Aims

To contribute insights for health promotion action, the aims of this thesis are to measure and compare the patterns and correlates of self-reported PA and SB in different occupational groups from PNG. The aims are addressed by a detailed review of evidence in developing countries, progressing to the main thesis study on PA, SB, and socio-demographic factors associated with these behaviours in groups of office, blue-collar and retail workers.

Methods

Following ethics approvals, a convenience sample (n = 402) of office, blue-collar and retail workers was recruited from public and private companies/organisations based in urban areas of Madang Province, PNG. Total and work-related PA and SB data were collected over 6 weeks (October 20th to November 27th, 2018) using an interview-administered survey comprising of items from the International Physical Activity Questionnaire (short form) and the Occupational Sitting and Physical Activity Questionnaire. Survey items also captured other lifestyle behaviours (e.g. smoking, alcohol use), and socio-demographic status (e.g. job type, education); physical measures (height and weight to calculate BMI) were taken by trained researchers. Tests of difference and logistic regression were used to analyse variations between occupational groups, and sociodemographic correlates for total and work time PA and SB.

Results

A total of 398 workers (office [n = 213], blue-collar [n = 133] and retail [n = 52]; 41% aged 26 - 40 years; BMI mean ± SD = 26.31 ± 5.097; n = 208 females) were entered into analyses. Overall, 97% (97% office workers, 99% blue-collar, 98% retail workers) of these workers achieved recommended PA guidelines (>600 MET-mins/week), with PA mostly achieved through walking, as opposed to moderate or vigorous PA; the median total sitting time was 7 hrs/day (Inter Quartile Range [IQR] 5, 9). For occupational comparisons, total PA was higher in retail workers compared to office and blue-collar workers although differences were not significant. Significantly higher ($p<0.05$) sitting time (total ≥7 hrs/day; and ≥50% of weekly work time) was reported in office compared to blue-collar and retail workers. Similarly, median percentage work hours spent sitting was higher in office compared to blue-collar and retail workers (Table 2. OSPAQ). In adjusted logistic regression analyses, compared to office workers the odds of high sitting in blue collar and retail workers were lower for total and workplace sitting (Table 4). Additionally, participants ≥40 years of age were more likely to report high total sitting and workplace sitting than participants <40 years.

Conclusions and Recommendations

This is the first study to investigate PA and SB differences between PNG occupational groups. While most participants met PA guidelines through walking, the data from the current study suggests that, compared to blue-collar and retail workers, older and office workers in PNG are a high need group for SB intervention. Piloting and use of a validated survey were study strengths. However, the limitation of using self-report measures highlights the need for future studies to use objective monitoring of PA and SB levels in different groups of PNG workers to confirm these results.

Declaration by Author

This thesis *is composed of my original work, and contains* no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

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Contributions by Others to the Thesis

Associate Professor Dr Nicholas D Gilson contributed to the development of the overall thesis objectives, provided support and guidance throughout the study and Dr Bronwyn Clark assisted with study design, analysis and interpretation of data. Both the supervisors contributed their significant input into editing written work contained in the thesis.

Statement of parts of the thesis submitted to qualify for the award of another degree

“No works submitted towards another degree have been included in this thesis”.

Research Involving Human or Animal Subjects

Ethical review and approval to human subjects were obtained from The Human Research Ethics Committee, The University of Queensland, Australia and The University Research Ethics Committee, Divine Word University, Papua New Guinea. Notification of the ethics approvals are included in Appendix B.

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Keywords

Physical activity, sedentary behaviour, sitting time, office workers, blue-collar workers, retail workers, PNG and developing countries, non-communicable diseases.

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List of Abbreviations

AP	activPAL
BMI	Body Mass Index
CI	Confidence Interval
DWU	Divine Word University
EE	Energy Expenditure
GDP	Gross Domestic Product
GPAQ	Global Physical Activity Questionnaire
HR	Heart Rate
Hrs/day	Hours/day
IPAQ	International Physical Activity Questionnaire
METs	Metabolic Equivalents
Mins/day	Minutes/day
MPA	Moderate Physical Activity
MVPA	Moderate-Vigorous Physical Activity
NCDs	Non Communicable Disease
OR	Odds Ratio
OSPAQ	Occupational Sitting and Physical Activity Questionnaire
PA	Physical Activity
PAST	Past Day Adults's Sedentary Time Questionnaire
PNG	Papua New Guinea
SB	Sedentary Behaviour
SPSS	Statistical Package for the Social Sciences

TV	Television
UK	The United Kingdom
US	The United States
VPA	Vigorous Physical Activity
WHO	World Health Organisation

CHAPTER 1: INTRODUCTION

Regular physical activity (PA) contributes to a range of health benefits that includes reduced risk of chronic conditions such as cardiovascular disease, type 2 diabetes, obesity and breast and colon cancer, [1, 2] as well as improvements in bone and muscle strength, and mental health/psychological wellbeing. [3] Further, physical inactivity, generally defined for adults as not achieving 150 minutes of moderate intensity PA/week has been identified as the fourth leading risk factor for global mortality. [4] However, physical inactivity is more commonly used to describe people who engage in none or very little PA (e.g. <30 minutes/week), and people not meeting the PA guidelines are referred to as "insufficiently active" (from this point onwards in the thesis 'inactivity' will be used as a general term to indicate people who are not achieving physical activity guidelines). One third of the adult population worldwide are inactive, while it is estimated that 5.3 million premature deaths are attributable to inactivity. [5]

There has been a worldwide decline in PA and energy expenditure (EE) over the past 50 years,[6] and this is projected to continue over the coming years towards 2030 with particular sharp declines in countries like China and Brazil. Such declines are largely driven by lower movement in occupational, domestic, and travel domains and are influenced by economic and technological advances and transition from agrarian jobs to industrial occupations. [7] In addition to lack of movement, prolonged periods of sedentary behaviour [8] (SB; sitting or lying down while awake at <1.5 METs energy expenditure) now seem to be the society norm across all parts of the world. [9] Indeed, prolonged periods of sitting time without interruptions while at work, watching television (TV), or during travel increase the risk of morbidity and premature mortality. [8, 10] While research suggests an interactive effect between PA and SB, a recent study with data from 54 countries (1,167,191,000 adults) indicated that engaging in high levels of sitting time (>3 hrs/day) resulted in a 4% increase in all-cause mortality. [11]

Literature on levels of PA and SB in developed countries (described as having a highly developed economy and advanced technological infrastructure relative to other less industrialised nations) is well established, and these studies provide a good base for intervention and action, particularly in the workplace, where lack of movement and prolonged periods of uninterrupted sitting are of particular concern. [11,12-16,17] For example, it has been suggested that adults spend one third to one half of their work time sedentary, and this duration may vary between different occupational groups (e.g. white collar office worker's vs blue-collar construction workers). [18, 19]

A recent systematic review on occupational PA and SB correlates reported that white-collar workers were at a greater risk of low occupational PA and higher sedentary time than blue-collar workers. [20, 21] Too much or too little of occupational PA and SB can have health consequences; as Straker et al., [22] highlight in their review of empirical evidence concerning the concept of the 'The Goldilocks Principle', balancing and varying PA and SB across the work day is important to achieve potential health and productivity benefits.

Compared to developed countries, the evidence base for different occupational groups in low-to-middle income developing countries is less evident. Quantification of PA and SB levels of developing world populations is needed given the transitional nature of work in these countries (e.g. movement from a predominately rural agricultural, to urban industry economic base), and the significant growth in lifestyle-related chronic disease risks and conditions. [23] The World Health Organisation (WHO) has reported that growing consumer demand, linked to the need to prevent occupational risks for workers, have led to the development of policy and practice to encourage healthy physical and psychosocial environments, personal health resources and strong community enterprise involvement in work communities from developing world countries. [24]

The United Nations ‘World Economic Situation and Prospects’ divides all countries of the world into three categories based largely on gross national income; these are developed economies, economies in transition and developing economies.[25] Papua New Guinea (PNG), with a growing population that currently stands at 8.2 million people, lies in the East Asian region and is a prime example of a large developing economic country experiencing major social transition.[26] PNG has an annual population growth of 2.3%, and a growing gross domestic product that is expected to triple the country’s exports by 2020. [24]

The country faces major prevention challenges for infectious diseases, maternal and child health, as well as a growing prevalence in lifestyle-related diseases which are placing a significant burden on health care costs. [27] In response to these health concerns, the PNG government developed a Strategic Plan (2010-2030) [28] to prevent and promote healthy lifestyles through improvements in nutritional status, reductions in smoking and alcohol consumption, and increases in PA. White and blue-collar occupational contexts play a key role in this plan, given that PNG’s economy is sustained by large group of workers engaged in agricultural, forestry, and fishing sectors, and increasing numbers in the office sector, with Gross Domestic Product (GDP) growing due to exports of minerals and energy. [29] This thesis is set against the background of the rapid industrialisation, economic development and health challenges so evident in PNG, and recognises the need for research to inform PA and SB health promotion efforts for PNG practitioners and policy makers. Consequently, the thesis study seeks to investigate PA and SB levels, and correlates of these behaviours, in different groups of PNG workers.

The thesis is set out in six chapters. Following on from this Introduction, **Chapter 2** provides a detailed literature review of key definitions and terms; PA and SB measures, and their relationships with health outcomes. This chapter includes a review of studies that have examined occupational PA and SB in developing countries, which in turn provides the rationale for **Chapter 3**, where the thesis aims and objectives are stated. **Chapter 4** describes the study methods, including design, recruitment and ethics, and measures, data treatment and analyses. **Chapter 5** presents the study results**,** while **Chapter 6** critically explores the study findings, implications for practice, and study strengths, limitations and recommendations for future research. Following references, appendices provide supplementary research materials which were developed and applied across the study timeline.

CHAPTER 2: LITERATURE REVIEW

2.1. Physical Activity Defined

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (EE) [30].

PA can be classified relative to four key characteristics.

- Frequency: This refers to PA repetition in regular or irregular intervals, and is typically measured in sessions per week.
- Intensity: The level of effort required for PA is characterised relative to EE and multiples of METs. As Figure 2.1 shows, PA can be performed at light (1.5 - 2.9 METs), moderate (3 - 6 METs) or vigorous (>6 METs) intensities. Examples of activities within these intensities include multiple house hold tasks, brisk walking and high intensity sport, respectively. [31]
- Duration: The amount of time spent physically active is measured in minutes (mins) or hours (hrs).
- Type: Refers to subcategories of PA that include exercise, which is structured, planned and consists of aerobic (jogging), strengthening, and/or stretching-based activities. Sport is identified here as a subcategory of exercise or PA that is competitive and usually vigorous in nature. Active travel and incidental PA that can include play or house work are also types of PA.

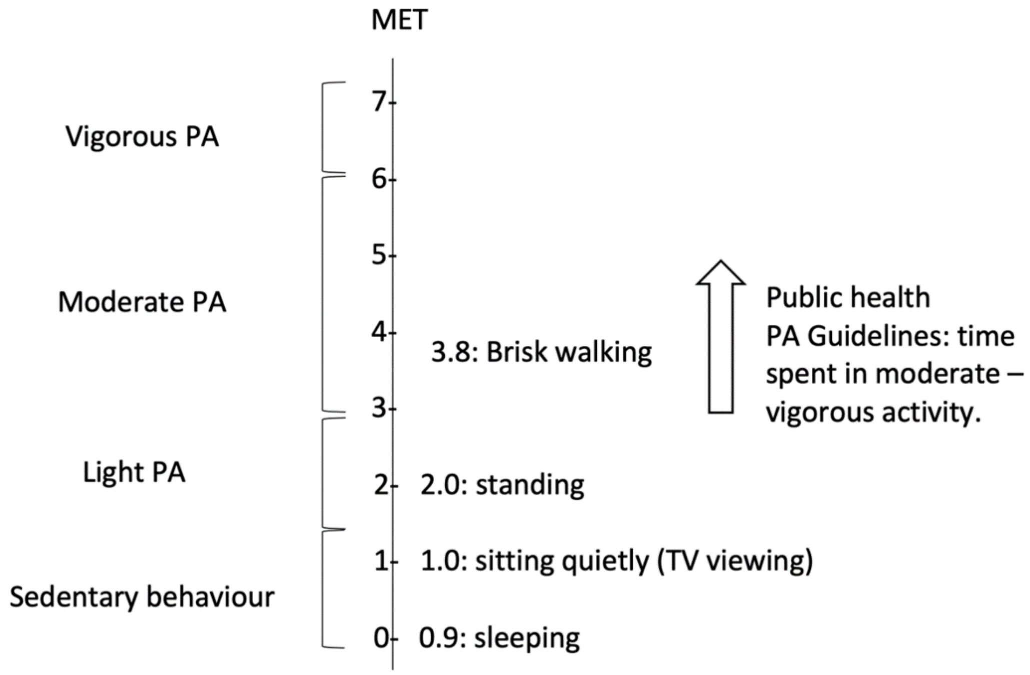

Figure 2.1. EE of activities in METs relative to intensity. [32]

PA intensity can be expressed in metabolic equivalents (METs), where 1 MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1kcal kg^{-1} $hour^{-1}$.[32]

2.2. Physical Activity Recommendations and Physical Inactivity

Health-enhancing PA recommendations reflect the four characteristics of frequency, intensity, duration and type. Low and middle-income developing countries have tended to adopt global recommendations for different age groups. [4] However, developed countries like the United Kingdom (UK), the United States (US) and Canada have specific national recommendations based on comprehensive reviews of evidence linking guidelines to a range of health and wellbeing outcomes.

The most recent Australian PA recommendations for adults aged 18-64 years [33] provide the following guidelines:

- Doing any PA is better than doing none. If you currently do no PA, start by doing some, and gradually build up to the recommended amount.
- Be active on most, preferably all, days every week.
- Accumulate 150 to 300 mins (2½ to 5 hrs) of moderate intensity PA, or 75 to 150 mins of vigorous intensity PA, or an equivalent combination of both moderate and vigorous activities, each week.
- Do muscle strengthening activities on at least 2 days each week.

In Australia, population levels of physical (in)activity have typically been assessed against the criteria of achieving 30 mins of moderate-to-vigorous PA (MVPA) on most days of the week (or accumulating a minimum of 150 mins of least moderate intensity PA/week). The 'Active Australia Survey',[34] a well-used Australian self-report tool, utilises a more detailed classification system reflecting total weekly EE to establish a continuum of (in)activity as follows:

- Inactive and no PA (0 MET-min/week).
- Not meeting PA guidelines and doing little PA (1-249 MET-mins/week).
- Some PA, but not meeting PA guidelines (250-499 MET-mins/week).
- Meeting PA guidelines (≥500 MET-mins/week).

These classifications are valuable in that they reflect the idea that while there is an optimal level of PA, health benefits can also be gained by the inactive doing some PA, even if they are not meeting minimal public health PA guidelines. [35]

2.3. Sedentary Behaviour Defined

As illustrated in Figure 2.1, Pate et al., [36] have described SB as low EE levels (1.0 - 1.5 METs), and further observed that in past research studies, physical inactivity and light intensity PA (LPA) have incorrectly been considered as SB (1.6 - 2.9 METs). Current consensus agrees that SB is distinct from physical inactivity (described as not meeting PA guidelines) and can be defined as:

> *"Any waking behaviour characterised by an energy expenditure ≤1.5 METs while in a sitting or reclining position."* [37]

This definition reflects low EE, as well as a posture sitting component during waking hours, now well accepted and used in the literature. [9, 38] As an example of considering EE and posture in combination, Thorp et al., [39] classified sitting or reclining activities ≤ 1.5METs as sedentary, whilst standing with this energy cost was not referred as SB because of the lack of a sitting postural component. Further to this, Owen et al., [8] have suggested that SB occurs in the three main contexts of occupation (eg. desk work), transport (eg. driving a car or sitting on public transport), and leisure time (eg. television or TV viewing).

Although the evidence base is growing rapidly in regard to SB, unlike PA there are no specific guidelines on the total amount and number of breaks that should be taken from sitting for health outcomes. [22] Pragmatic suggestions from the literature propose at least a five-minute break from sitting every 30 - 60 mins block of time. [40, 41] Hence, the guidelines that are available tend to be generic and encourage people to sit less and move more as often as possible. [42, 43]

2.4. Physical Activity and Health Outcomes

Lee et al.,[44] indicated that the benefits of PA for health have been recognised since ancient times by physicians from China in 2600 BC and by Hippocrates in 400 BC. Modern perspectives began to evolve in the mid-20th century, where there was recognition and an increased research focus on physical well-being and the prevention of chronic diseases resulting from PA. Therefore, the current PA recommendations are based on a strong and well developed evidence base linking regular PA participation with a wide range of physical and psycho-social health benefits.

Modern epidemiological perspectives on PA and health were first observed in a 5-year follow-up study by Morris, [45] amongst London bus drivers and conductors. The findings indicated that bus drivers, who were sedentary because of their occupation, had a higher risk of developing cardiovascular disease compared to conductors, who spent most of their work day being physically active moving around selling and checking fares. Similarly, a 16-year longitudinal study by Paffenbarger et al., [46] amongst US shipyard workers found that the incidence of coronary heart disease and mortality was one-third higher in sedentary (reduced calorie expenditure) compared to active workers. The authors concluded that PA plays a major role in preventing rates of chronic disease and death. Another 10-year follow-up study by Paffenbarger et al., [47] amongst Harvard Alumni (16,936 men aged 35 - 74 years) also showed that those who were physically active (>2000 kcal/week) had a lower risk of heart attack compared to alumni who expended lower levels of EE.

Building on the formative work of Morris and Paffenbarger, the American College of Sports Medicine were the first organisation to develop recommendations aimed at informing the public about the importance of exercise and PA to promote health. [48] These recommendations tended to focus on exercise regimes for developing and maintaining cardiovascular fitness in healthy adults with guidelines that advocated PA frequency of 3 of 5 days/week, at an intensity of 50-85% VO_2 Max, for a duration of 15 - 60 mins.

A broader and more inclusive perspective on public health and lifestyle PA evolved in the late 20th century to the present day. The seminal US Surgeon General's report [49] released in 1996, provided strong evidence on the wide range of health and quality of life benefits associated with regular participation in moderate PA (MPA) that could be brought about through day-to-day activities such as walking. Benefits included reduced risk of premature mortality and coronary heart disease, and a lower prevalence of hypertension, colon or breast cancer, diabetes mellitus, falls, osteoarthritis, osteoporosis and obesity. Along with these physical health benefits, strong evidence also highlights the benefits of PA for psycho-social health that helps to reduce depression and anxiety, improve mood and enhance the ability of people to cope with day to day tasks or activities. [50-52, 53, 54]

The strong public health impact of PA is perhaps best illustrated by data suggesting that if PA guidelines were attained worldwide, population life expectancy would increase by 0.68 years. [44] Australia's Health 2016 [55] highlights a decline in overall death rates, coronary heart disease and diabetes associated with lifestyle behaviours that include PA, as well as nutrition, alcohol and tobacco use. Additionally, a study has estimated that Australia's direct health care cost due to physical inactivity is 66.4%, 14.2% and 19.4% respectively paid by the public, private sector and households (out of pocket). [56] Lastly, Canada and the US reportedly spent 2.5% and 2.4% of their total direct health care costs on chronic diseases resulting from physical (in)activity, with around a third of deaths being preventable through PA. [57]

In summary, based on the strong epidemiological evidence base, and landmark studies and reports, consensus advocates a curvilinear dose-response relationship between PA and health. [35] As Figure 2.2 shows, the biggest benefits to health and reductions in mortality are seen when the most inactive engage in some activity. This is consistent with the idea that some PA is advantageous for health, even if optimal recommendations are not being met.

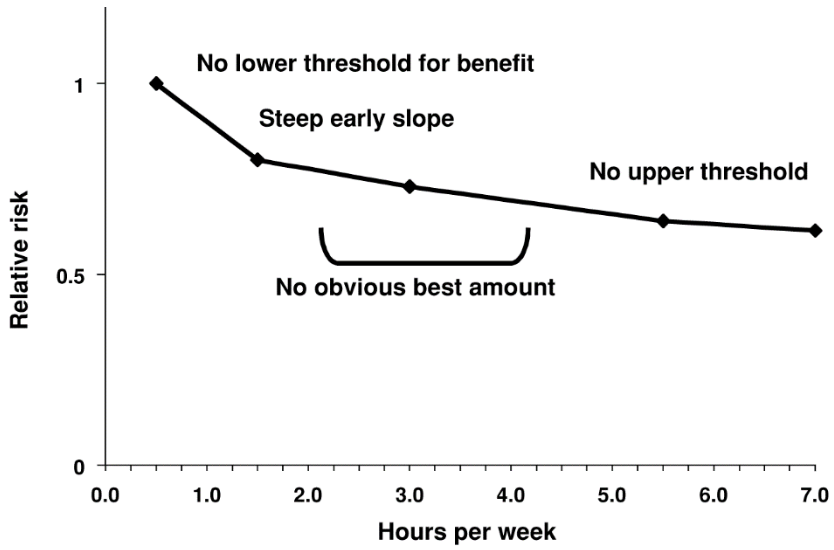

Figure 2.2. Risk of all-cause mortality by hrs/week of MVPA. [35]

2.5. Sedentary Behaviour and Health

Compared to the established relationship between PA and health, research into associations between SB and chronic disease is relatively new and has significantly developed over the last decade. This body of evidence highlights a strong and emerging relationship between total time in SB, prolonged sitting in different domains, and breaks in sitting, and a variety of health and disease outcomes.

For example, Owen et al., [8] reviewed a number of studies investigating SB and chronic diseases, and reported associations between TV viewing and mortality, whereby the life expectancy of Australian adults was reduced by 22 mins for every hour spent watching TV. Dunstan et al., [58] has reported that at least half and up to two-thirds of the waking day is spent sedentary, resulting in decreased EE and adverse health consequences. A recent review collated and discussed studies on detrimental health concerns that included all-cause mortality, cardio-metabolic risk factors, cancer, musculoskeletal disorders and mental health issues.[22] This was consistent with a systematic review of longitudinal studies done by Thorp et al.,[59] which included an increase in weight gain and obesity and other health consequences.

A large study by van der Ploeg et al.,[16] with 227,497 Australian adults showed that sitting for 8 - 11 hrs/day resulted in poor health outcomes and a 15% increase in risk of death from all causes; this risk increased to 40% for 11 or more hrs/day of total sitting time. Another large prospective study[60] with 240,819 adults from the US, reported associations between total sitting time of >7 hrs/day, and a 50% higher risk of all-cause mortality. This study also suggested that meeting PA recommendations did not compensate for SB, therefore highlighting the importance of targeting PA and SB.

Thus, large volumes of sitting has been found to have a strong relationship with mortality rates, despite adults being physically active,[61] while Hamilton et al.,[62] have also raised the idea that prolonged sedentary time leads to poor metabolic and cardiovascular biomarkers independent of PA. At present, there is contentious debate concerning the interactive health effects of PA and SB, where some studies have shown that PA impacts the SB disease association.[63] A meta-analysis of more than 1 million men and women on sitting time reported that 60 - 75 mins of moderate intensity PA/day removed the risk of death linked to sitting, and reduced the risk specifically associated with TV viewing.[10]

While uninterrupted sitting has been linked to detrimental metabolic consequences, breaking total sedentary time with standing or light intensity movement has been suggested as being beneficial for metabolic health.[64] For example, 2-minute bouts of interrupted sitting every 20 mins has been shown to reduce post-prandial glucose and insulin responses amongst obese/over-weight adults. [65] A 54-country analysis by de Rezende et al., [11] observed that a 10% reduction in sitting time (30 mins/day) could reduce all-cause mortality by 6%, whilst a 50% reduction would result in a three-fold reduction in mortality. Suggestions on breaks to reduce sitting time included decreasing SB by 4 hrs/day, and encouraging movement every 30 mins. [22] However, it should be recognised that the optimal amount of sitting interruptions required to promote health is unclear.

2.6. Measurement of PA and SB

Measures of PA and SB are classified as subjective or objective and can be used by researchers and practitioners to evaluate the characteristics of PA and SB. Subjective measures require participants to assess their own PA and/or SB. Objective measures involve researchers directly observing and recording behaviours as they occur, or more commonly, using an instrument or device to assess behaviours or associated physical responses (i.e. heart rate).

2.6.1. Subjective Measures

PA logs, diaries and questionnaires ask participants to recall behaviours over a particular time period, ranging from a specific activity session to a general indication of typical activity. [38] Logs provide lists of physical activities which the participant chooses from to indicate what has been completed during a day or at the given time period (e.g. 15 mins). PA diaries are used to collect more detailed and comprehensive data concerning PA frequency, duration, intensity and type, typically over a week.

PA and SB questionnaires are commonly used measurement tools because they are inexpensive, and easy to apply to large populations. However, they tend to be limited with regard to social desirability and recall bias. [66] The *Active Australia Survey,* [34] a short, valid and reliable questionnaire that can be completed in person or via telephone interview, was developed in 1997 and has been extensively used to measure the leisure time PA of Australians. Another well used self-report measure, utilised to measure PA and SB in studies across the world is *The International Physical Activity Questionnaire.* [67] The IPAQ has a long (5 activity domains) and short (4 generic items) version that can be either self-administered, or used by researchers over the telephone; the questionnaire is available in multiple languages, and has been used to examine intercountry differences and large-scale data amongst 20 countries. [9] The English language version has been shown to have acceptable reliability (r_s = 0.8), and validity (r_s = 0.3) compared to an objective criterion measure. [68]

Compared to PA self-reports, questionnaires that specifically measure total sitting time and SB in the different domains of work, transport and leisure are a relatively recent development. Healy et al., [69] reviewed a range of SB self-report questionnaires and evidenced acceptable reliability and validity, particularly in domains of work and TV viewing. An example of a popular, well used SB self-report is the 7-item *Past-Day Adult's Sedentary Time* (PAST) questionnaire. The PAST can be administered in under 10 mins, has good test-retest reliability, criterion validity, and has been found to respond to group level changes in interventions that target SB. [70]

2.6.2. Objective Measurement

These types of measures can accurately assess physiological and/or biomechanical parameters of PA and SB. Commonly used objective measures include heart rate (HR) monitors, pedometers, accelerometers and inclinometers. [38] Many of these devices are primarily used for measuring movement; some can be used to assess SB, or sitting.
HR monitors capture HR intensity, brought about through the response of the cardiorespiratory system to movement. [71] Modern commercially available HR monitors are relatively cheap and accurate, and consist of two parts (a wireless chest strap and wrist worn watch) that can transmit electrical signals of the heart to the watch, and store HR data for download and analyses using preparatory software. At a general level, time spent in HR intensities can then be used to estimate PA time (e.g. MVPA mins spent >139 beats/min). [72] Limitations of HR monitoring include the chest strap being uncomfortable to wear for long durations as it irritates the skin, a non-linear relationship between HR-VO_2 at low and high intensity exercise, [73] and that HR values are affected by prescription drugs such as ß blockers. [38]

Pedometers, usually attached to a belt and worn on the hip, are used to measure step count frequency. In basic terms, the casing of the device houses a pendulum attached to an electronic circuit by a spring, which connects and counts each time a step is taken. Crouter et al., [74] have shown that out of 10 pedometers studied, the Yamax Digiwalk-500 evidenced the best validity in measuring steps, distance and calories consumed during walking. Recent developments in smart phone applications, now also allow the measurement of step counts and can be used as a self-monitoring strategy to increase and regulate PA participation. [75]

Furthermore, commercially used fitness trackers like Fitbit® or Nike© are also available at low cost, and provide feedback and motivation, although their accuracy has been questioned. [38] Tudor-Locke, et al., [76] have developed step count categories for classifying pedometer PA levels. Whilst, these categories are useful, they do not capture intensity of movement, which along with not capturing non-ambulatory activities such as cycling, can be recognised as a key limitation of using step counts and pedometers.

Accelerometers are now arguably the most commonly used objective measure of PA and SB based on their accuracy, relative low-cost and practicality. [38] They are usually worn on the hip or wrist, and specifically measure the frequency and amplitude of movement in one or more planes; device data provide an indication of the frequency, duration and intensity of PA, and through the absence of movement an estimation of SB. [73] Hip worn accelerometers are more reliable to measure normal movements, and are typically worn for 7 days. [77] An earlier study by Freedson et al., [78] has shown a validated cut-point threshold using the CSA accelerometer-5032 (Computer Applications Inc.) of 1952-5724 counts/min as being indicative of MPA.

Traditional accelerometers are unable to assess posture and have used a cut point of <150 counts per minute to estimate SB. [79] Nevertheless, recent models such as the ActiGraph GT3X and GT3X+ combine accelerometry with an inclinometer capable of measuring posture and therefore sitting, standing and lying. [77] A study by Kozey-Keadle et al., [79] showed the ActiGraph cutpoint of 150 counts/minute to be the most accurate measure of SB. A more recent study also found that the actiPAL (AP) was a valid tool to assess sitting, standing and stepping when compared against a direct observation criterion. [66] Indeed, the AP provides a high quality measure of SB and has been suggested to overcome the over or underestimation of SB when measured by an accelerometer alone. [69]

2.6.3. Summary of Measures

The strengths and weakness of measurement techniques of PA and SB are essential to consider when designing a study that can be achievable and assesses the appropriate outcomes. Subjective, self-report measures enable cost and time effective assessment of large population samples over varying periods of time. Also, these types of measures allow investigation into activity types and contexts, and relationships and socio-demographic factors that contribute to PA and SB. [80] Though objective measures tend to provide accurate, detailed data and are very applicable to intervention studies, some also tend to be expensive. Compliance is hard to manage as some people do not like to wear devices, data can be lost due to equipment malfunction, and importantly objective measures typically do not provide data on activity type, unless used with a record or activity log.

2.7. Prevalence of PA and SB

A recent analysis by Guthold et al., [2] with 2 million participants from 168 countries reported 27.5% of adults were physically inactive (23.4% men and 31.7% women). The previous study by Sallis et al., [81, 82] estimated physical inactivity rates amongst adults changed from 31.1% to 23.3% between 2012 to 2016 amongst 146 countries. A more recent study reported one third of the global adult population does not meet recommended guidelines and 5.3 million deaths/year are due to physical inactivity. [5] Research using the IPAQ described ≥5 hrs/day of sitting across 12 countries resulted in health risk; the study also described a linear inverse relationship between PA and sitting time. [9]

Studies from developed countries using self-reported sitting time amongst 30,000 participants from 32 European countries, [83] and accelerometers with 6,329 participants from the US [84] have shown that average sedentary time was 5 hrs/day and 7.7 hrs/day respectively. Furthermore, the Australian Health Survey [85] has shown similar self-reported findings of 5.6 hrs/day of SB, with sitting at work, TV watching and computer use common forms of SB. Research has consistently shown that adult SB mostly occurs at work with occupational sitting a major contributory factor for prolonged sitting time. [19, 66]

2.8. Occupational PA and SB

Decreases in manual labour jobs, and increases in office-based work over the past 50 years in developed nations have resulted in low levels of population EE through a high prevalence of occupations involving sedentary desk-based activities. [6] This is combined with technological advancement in modern work environments, which has reduced opportunities for movement and promoted prolonged occupational sitting time. [19]

Amongst the domains of SB, sitting in an occupational setting accounts for the highest level of daily sedentary exposure [13, 19, 22, 86] For example, Parry et al., [87] examined Australian office workers' sitting time using accelerometers and reported 82% of work time was spent sitting; this is relatively consistent with findings by Thorp et al., [39] who found that 76% of accelerometer assessed work time was spent sitting.

In an earlier study, Mummery et al., [88] investigated the relationship between occupational sitting time, and overweight and obesity in different occupational groups in Australia, using cross-sectional self-report data collected via a computer-assisted telephone interview. The occupational groups were classified as professional, white and blue-collar workers. They observed an average occupational sitting time of >3 hrs amongst all groups, whilst 25% of the study population spent >6 hrs of sitting during a work day. However, there were significant differences amongst the three working groups, with professionals (249 mins) spending more time sitting at work than white (207 mins) and blue (136 mins) collar workers.

Similarly, two studies [18, 21] measured occupational sitting time using interview and computer-assisted cross-sectional surveys with a variety of Dutch working groups. Managers (495 mins/day), professionals (441 mins/day), and clerical occupations (477 mins/day) spent more total time sitting, compared to trade, technician, labour and transport workers (381 mins/day), and agricultural (333 mins/day), and commercial workers (404 mins/day). Similar working groups from Australia varied in total sitting time (managers, professionals, clerical and administrative workers = 4.3 - 5.6 hrs/day, and technicians, trade workers and labourers = 1.4 - 1.8 hrs/day). These data suggested that blue-collar workers are exposed to higher occupational PA and lower levels of sitting, compared to white collar and professional workers.

2.9. Occupational PA and SB in Developing Countries

Reflecting those changes that have occurred in developing countries over the last 50 years, fundamental shifts from an agricultural to an industrial based economy are currently occurring in many developing countries, resulting in reductions in labour intensive work, and increases in sedentary work and chronic conditions such as obesity, heart disease and type 2 diabetes. [61] Reductions in occupational EE through changes in the nature of work are compounded by developing countries adopting technology at the workplace, in transportation and domestic environments, which decreases movement and encourages prolonged sitting. [8]

Most recently, a report by de Renzende et al., [11] on all-cause mortality associated with sitting time amongst 54 countries (developed and developing) estimated that close to 4% of all deaths were due to prolonged sitting time. While the findings of this study highlighted that Western Pacific countries (Australia, Cambodia, Cook Islands, Kiribati, Malaysia, Micronesia [Chuuk], Tonga and Vanuatu) reported some of the highest levels of sitting (>3 hrs/day), data tended to mainly focus on occupational PA and SB in developed nations. Indeed, it may be suggested that there are currently limited studies available on occupational PA, SB and associated health concerns in developing countries. [89, 90]

A recent study amongst 47 low and middle-income countries (n=196,742) showed a 23% prevalence of physical inactivity in all occupations apart from agriculture, with improvements in the economic and social development of a country resulting in an increase in the number of white and blue-collar occupations. [91] However, compared to that available for developed countries, a cursory review of the available literature suggests that fewer studies have measured occupational PA and SB in workers from developing countries. To examine this question in more depth, a literature search was undertaken of pertinent databases, to identify studies that have investigated PA and SB exposure in low-to-middle income developing countries.

2.9.1 Protocol, Inclusion Criteria and Data Extraction

The databases PubMed, MEDLINE and Web of Science, Scopus, EBSCO, PsycINFO, and Science Direct were searched for relevant studies to May 2018. The keyword search was performed using the terms PA OR SB OR sitting* AND developing OR low OR middle income countries* AND occupation OR white collar OR blue-collar workers OR workplace. Additional papers were identified by manually checking the reference list of the included papers.

English language articles included in the review were required to be published in academic peer-reviewed journals, and report data on PA and/or SB (inclusive of sitting) in non-clinical populations of white and/or blue-collar workers from developing or low-to-middle income countries (classified using the *United Nations' World Economic Situation and Prospects* classification system). [92] Book chapters, abstracts of conference proceedings, and dissertations were not considered. Two reviewers (the candidate and lead supervisor) independently performed the selection of articles and examined titles, keywords, and abstracts, and removed out of scope papers. Any disagreements on inclusions were resolved through discussions between the reviewers.

For selected papers, details on authors and year, study aim and design, study description and participant characteristics (proportion of men and women, mean age and country), were extracted. The team also identified PA and/or SB measurement approaches, and study outcomes and conclusions relative to occupation; while not the main variables of interest, data was extracted on other health outcomes (i.e. obesity or cancer) where reported in combination with PA and SB.

2.9.2. Literature Review Findings

The flow diagram depicting the search process is shown in Figure 2.3. After removing the duplicates, the electronic database search yielded 3480 records, four additional papers were identified through other sources, for example from the reference list of review papers. After excluding records that were duplicates, the titles and abstracts of 2630 papers were screened for eligibility and 2599 papers were rejected (reasons for exclusions are summarised in Figure 2.3). A total of 31 full-text papers were reviewed for eligibility. Seven of these papers were removed as occupational PA and/or SB was not reported, leaving 24 papers that met inclusion criteria for entry in the literature review.

The aims and characteristics of the included studies are summarised in Table 5. (Appendix A). The study designs varied, and included 17 cross-sectional analyses, [9, 89, 91, 93-106] three population-based longitudinal surveys, [9, 90, 107] two prospective studies [108, 109] and a case control [110] and comparative study. [111] The studies were conducted from various countries, in which four studies were conducted in China, [90, 107, 108, 110] India, [97] Nepal, [101] three studies in Malaysia, [89, 98, 100] two studies from Papua New Guinea, [102, 111] three from America (South and Central America), Northern Caribbean Island, [93, 104, 106, 109] and five studies across Africa (East, West, Southern and Central Africa). [94-96, 103, 105] Three studies included multiple developed and developing countries. [9, 91, 112] Twenty two studies assessed men and women, [9, 89-91, 93-107, 109, 111, 112] whilst two studies included only female participants. [108, 110] The sample size of the included studies ranged from 56 [111] to 196,742 [91] participants, with age ranging from 15 [99] to ≥ 65 years. [9, 89, 91, 94-104, 106-112]

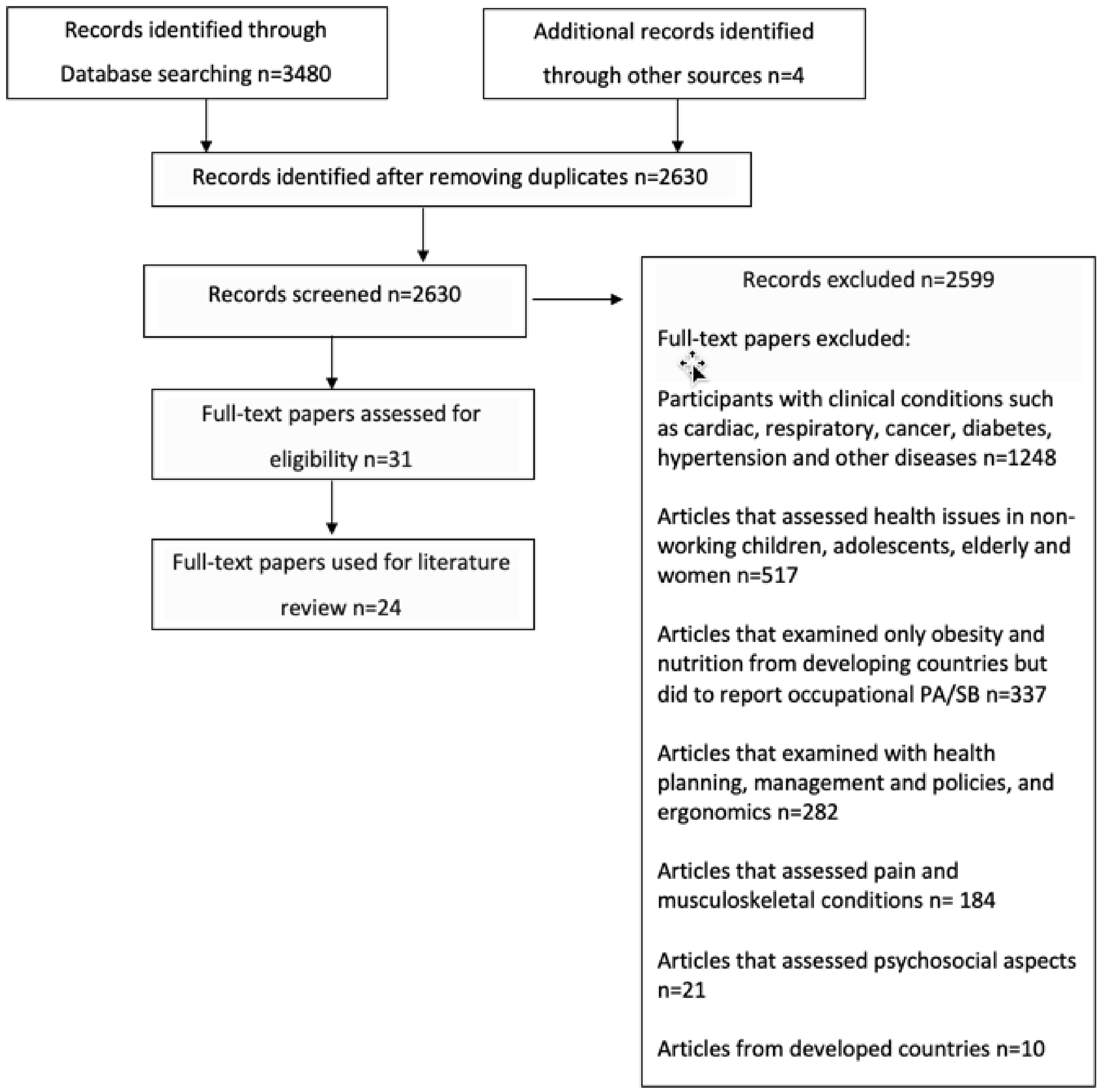

Figure 2.3. Flow diagram of papers identified from review

Reviewed studies focussed on PA levels SB and associated factors, assessed with occupational groups living in rural and urban regions. Table 6 reports the measures, study outcomes and conclusions of selected studies (Appendix A). The short and long-form IPAQ was the most popular self-report measure (9 studies), [9, 89, 91, 98-100, 102, 104, 106] while five studies used the Global Physical Activity Questionnaire (GPAQ). [95-97, 101, 103] Two studies utilised both objective and subjective measures, [93, 94] whereas an objective measurement alone (HR monitoring) was used in two studies. [105, 111] Four studies used a unvalidated, structured questionnaire to interview participants, [90, 108, 109, 112] while one study used data from multiple surveys over time in various countries. [107]

Seven studies [91, 97, 98, 102, 103, 107, 112] found a relationship between higher economic status and lower PA levels. Six studies [9, 89, 93, 101, 106, 107] correlated occupational PA and education, where participants with higher education were less active, and also experienced higher levels of sitting of more than 5 hrs/day, compared to participants with only primary education. [89, 107] Additionally, two studies [95, 99] reported participants with no formal education or less than primary education were the least active. Further, four studies [9, 89, 108, 110] specifically reported on SB data (sitting), where higher sitting duration was directly associated being lower levels of PA and MPA.

Reporting of PA levels in white and blue-collar occupational groups in developing world contexts was very limited, although study findings identified a number of key themes. Occupational PA was the major factor contributing to total PA. [93, 97, 103] Additionally, leisure time PA was not common amongst samples in the developing nations included in the review [90, 112].

The findings of seven studies [9, 90, 91, 105, 107, 111, 112] highlighted that due to urbanisation and increases in socioeconomic growth, those involved in highly physically demanding or active work (intense occupations such as agriculture) were transitioning into more sedentary work (office-based occupations in government, semi government or private sectors). Linked to this, lower levels of PA were commonly found amongst populations living in urban as opposed to rural areas (reflecting the propensity for office-based work in urban areas).[94, 96, 97, 101, 103, 105, 107, 112]

Based on the data extracted from selected studies, education level played a key role and acted as a proxy for occupation and income in many studies.[9, 97, 102, 106, 112] In these studies, PA was found to be lower amongst higher educated individuals, who also spent a greater amount of time sitting.[9, 89, 93, 101] Moreover, higher educational level was linked to office based, white collar occupations,[91] which in turn led to higher occupational sitting and lower levels of PA.[106] In contrast, studies commonly reported 'blue-collar workers' with lower educational backgrounds were more physically active and sat less.[89, 93, 94, 98, 107, 112] Additionally, studies indicated that those who possessed no formal education, and were unemployed, were highly sedentary and the least active.[95, 99]

Studies included in the review[91, 93, 96, 97, 101, 112] identified that a higher prevalence of SB, and/or physical inactivity, was due to an ongoing transition from an agricultural to an industrial-based economy, and technological advancement at work, transport and in the domestic environment. Table 6 (Appendix A) also summarises the findings for those studies that reported occupational PA, SB and associations with disease-related outcomes. High levels of SB were related to higher risks for chronic conditions and diseases such as ovarian and breast cancer,[108, 110] a 3-fold increase in the incidence of metabolic syndrome[89, 100, 101,] and increased Body Mass Index (BMI) and weight gain.[102, 111].

CHAPTER 3: THESIS RATIONALE AND AIM

3.1. Summary of Literature Review and Research Needs

Large population studies evidence strong relationships between PA, SB and health outcomes. In developed countries, particularly in the workplace, the growth in sedentary occupations has reduced EE and opportunities to be regularly physically active, and contributed to a high incidence of chronic disease. The literature review undertaken and presented in Chapter 2 indicates that developing countries are also following this path as economies rapidly move from an agricultural to an industrial base.

However, compared to developed countries, there seems to be limited available evidence on the prevalence of PA and SB of workers from developing countries. Studies that measure, map and compare these behaviours in these different occupational groups from developing countries are therefore needed to identify where interventions are best targeted, and those factors that may be associated with the levels of PA and SB.

3.2. Papua New Guinea: PA, SB and Health Issues

PNG is a developing country where PA, SB and health research is urgently required. This country is a culturally diverse nation in Oceania with a population of 8.2 million people living in 600 small islands. More than 800 indigenous languages are spoken, and 13% of the population live in urban areas. GDP is increasing rapidly, particularly in the industrial sector (43%) compared to agriculture. [113] The action plan for the prevention and control of non-communicable diseases (NCDs; 2014 - 2020) in the Western Pacific [114] indicates that 80% of all deaths in this region are due to cardiovascular diseases, diabetes, cancers and chronic respiratory diseases. With a growth rate of 2.7%, the population of PNG is expected to reach 30 million in 2030 and twice that in 2050. Industrialisation, lack of urban infrastructure, and poor education in this growing working population are likely to lead to detrimental changes in lifestyle behaviours such as PA, which in turn are anticipated to lead to further increases in chronic diseases and conditions. [27]

The review carried out for this thesis identified only three studies that have investigated work-related PA and SB studies with PNG samples. The first of these, 'The PNG NCDs Risk Factors STEPs Survey' highlighted that occupational PA (men = 115 mins/day, and women = 102 mins/day) was the largest contributor to total PA participation, with active transport and leisure time contributing the least. Additionally, 99% of the population sample aged 26 - 64 years showed a moderate to high combined risk of NCDs. [115] The two other studies highlighted that changes in the nature of work are contributing to a growing chronic health problem in PNG. Specifically, study findings suggested that urban populations were more physically inactive at work, and that the growth in sedentary white collar jobs, and use of motor vehicles for transportation to work, have resulted in increased body weight amongst Papua New Guineans. [102, 111]

3.3. Thesis Aim

In an effort to contribute to the formative evidence base on PA, SB and health issues in PNG workers, and developing countries elsewhere, the study presented in this thesis aimed to:

- Measure and compare the patterns and correlates of self-reported PA and SB in different occupational groups from Papua New Guinea.

Specifically, a cross-sectional descriptive study design was conducted, that sought to assess occupational and non-occupational PA and SB in PNG office, blue-collar non-office, and retail workers using an interview-administered, standardised and validated self-report survey. The study methodology is discussed in detail in the following Chapter 4, and the results presented in Chapter 5. A critique of the study findings, and implications for ongoing research and health promotion practice are provided in Chapter 6.

CHAPTER 4: METHODS

This chapter will describe the research approach in detail. This includes the study design and ethics approvals process, and the methods used for recruiting the PNG organisations and workers who participated in the study; selecting, piloting and then administering survey measures of worker PA, SB and other associated variables such as demographics, nutrition, alcohol and smoking behaviours; and treating and analysing the collected data.

4.1. Study Design and Ethics Approvals

The study used a cross-sectional descriptive study design to assess self-reported levels of PA and SB in three urban occupational groups of workers (i.e. office, blue-collar and retail) employed in a range of PNG organisations. Demographic (e.g. age) and lifestyle (e.g. nutrition) factors associated with total and work-related PA and SB were also explored as part of the research design.

Prior to recruitment and data collection, ethical approval to conduct the research was received from the candidate's host institution (The Human Research Ethics Committee, The University of Queensland, Australia; #2017001343; 17.10.2017). Approval was also received from a partner institution acting as the research facilitator in PNG (The University Research Ethics Committee, Divine Word University, [DWU] Papua New Guinea; #10-2017; 19.10.2017). Notification of the study ethics approvals are included in Appendix B

4.2. Recruitment of Organisations and Participants

Recruitment was undertaken in Madang town, Madang Province, PNG. Organisations targeted for recruitment were sourced from those known to the candidate and from a search of the Madang Business Directory. Organisations were chosen to ensure a mix of occupational groups for assessment and analyses. To seek approval to conduct the survey, the managers and/or the Directors of 21 organisations were approached via email or in person, and provided with details on the study aim and protocols.

Following this process, two organisations declined, with another company not progressing to survey following initial agreement. Therefore 18 small-to-large organisations (range of 7 to 300 employees) agreed to take part and progressed to survey distribution. Appendix C describes the nature and size of each organisation, with employees working in occupational environments that included a garment manufacturing factory, supermarkets, technical operating groups (e.g. electricians, plumbers and telecom engineers), and an oil production company. Provincial and Local level Government were also approached, and comprised of Departments such as commerce industry and tourism, human resource, health works, information and media, agriculture and livestock, forestry, transport, education and teaching, finance and treasury, justice, and fisheries.

Based on the resources available to conduct a researcher administered survey with physical measures, within a limited two months timeframe, a convenience sample of at least 400 workers was sought from participating organisations (59% of response rate from a potential participant pool of 1066 employees). There are no standard classifications of workers, and so allocation of occupations to these groups were discussed, and agreed by consensus amongst the research team, based on the predominate contexts (i.e. office, or non-office manual) in which the occupations occurred. These classifications were made to reflect the type of PA that might be expected from the roles within those broad categories.

- Office workers: Administrators, accountants, clerical assistants, executives, managers and directors.
- Blue-collar workers: Mechanics, electricians, plumbers, engineers, technicians, drivers, machinists (production or manufacturing), carpenters, and builders.
- Retail workers: Cashiers, and checkout or sales assistants.

Human resource personnel from participating organisation coordinated and facilitated the recruitment of these occupational groups into the study. The recruitment process began with distribution of study information to workers, followed by face-to-face researcher contact to further explain study aims and protocols. All participants provided informed consent, and to incentivise participation, workers were provided with a small voucher (mobile top-up of Kina 5.00) following completion of measures.

4.3. Measures

To investigate the stated aims of the thesis, a survey was compiled of existing self-report measures. The key factors in the selection of measures were as follows:

- Valid and reliable English language items (the official language of PNG) that assessed PA and SB (both total and work-related), key socio-demographic characteristics, and lifestyle behaviours.
- Items that could be administered by interviewers (to facilitate understanding and data accuracy for participants with a range of educational levels), within a 20 minute time period.

4.3.1. Total PA and SB: The IPAQ

The IPAQ (short form) is an extensively used, validated and reliable English language, self-report survey of PA and SB. The questionnaire comprises of seven items that measure the time spent (number of days/week and the duration of hours/minutes per day) in MPA, Vigorous Physical Activity (VPA), walking, and sitting [67] A detailed review of the validity and reliability of the IPAQ is presented in Chapter 2 (Section 2.7). The IPAQ short version was chosen for use in this study as it is time efficient self-report that had minimal impact on the restricted time workers were able to provide to complete the survey. In addition, its use complemented the work specific tool (OSPAQ), that measured occupational SB, standing and PA.

4.3.2. Work Related PA and SB: The OSPAQ

The Occupational Sitting and Physical Activity Questionnaire (OSPAQ) measures occupational PA and SB. The survey consists of 2 items that assess; the number of days and hours worked over the week; and the percentage of working time (typical day over the past seven days) spent sitting, standing, walking and in heavy labour [116]. The OSPAQ has been found to have moderate-to-excellent test-retest reliability, [117] and good criterion validity was reported relative to objectively measured (AP) occupational sitting and standing time. [66] This questionnaire is highly recommended for population studies that measure lifestyle behaviours and health outcomes. [117]

4.3.3. Socio-demographics and Lifestyle Behaviours

Survey items were also chosen to assess demographic characteristics and other lifestyle behaviours of participants. Demographic items included age categories (18 - 25 years; 26 - 40 years; 41 - 60 years; >60 years), gender (male or female), height (m) and weight (kg), was objectively assessed and education (primary school; high school; secondary school; diploma, certificate, degree or higher degree). BMI (kg/m^2), was categorized as underweight (<18.5 kg/m^2), normal weight <25 kg/m^2, overweight (25 - 30 kg/m^2), obese (≥30 kg/m^2). [118]

Items on other health behaviours besides PA and SB included nutrition (2 items on how many servings of fruits and vegetables in a day), alcohol (3 items that referred to the consumption of alcohol in the past 12 months, and the number and frequency of standard alcoholic drinks), and smoking (1 item assessing if participants had smoked, never smoked, or given up smoking).

4.3.4. Pilot Survey

Prior to roll-out in the larger study, and in line with recommendations to improve content and face validity of surveys, [119] items were piloted with PNG nationals recruited from the DWU (n=12; academic personnel, office workers, and construction and retail workers). Feedback provided by this sub-group identified issues on the accuracy of self-reporting height and weight, estimating the serving size of fruits and vegetables, understanding the terms 'sedentary behaviour, and moderate and vigorous PA', and reporting the duration of activities in minutes, hours, and percentages.

In response, the survey was adapted whereby items on self-reported height and weight were removed (with physical measures added to the research protocol; see Section 4.3.5). Show cards were used to facilitate understanding of food servings, standard units of alcohol, and examples of percentages of occupational sitting, standing, walking and heavy labour. 'Sedentary behaviour' was replaced with 'sitting', while researchers used prompts and descriptions of physiological responses (i.e. breathing and heart rate), to facilitate worker understanding of differences in PA intensity. Appendix D contains the final survey distributed to recruited workers participating in the main study.

4.3.5. Survey Administration and Physical Measures

Data collection occurred within a six weeks period from October 20th to November 27th, 2018. The candidate and research assistant administered measures, assisted by a team of five additional researchers (colleagues and students) who facilitated when required.

Participants provided informed consent immediately before researchers administered the survey, with items typically completed within 15 to 20 minutes.

Following survey completion, height and weight were measured using standard protocols, whereby participants stood upright while not wearing shoes. Height was measured twice to the nearest 0.2 cm using a Seca 213 portable stadiometer, [94] and weight (kg) was measured twice to the nearest 0.1 kg using a calibrated weighing scale (Body Fat and Hydration Electronic Scale). The researchers were trained, to ensure standardised methods for administration of survey and physical measures. During the session a mock survey was practised amongst the team, and item queries raised and clarified by the candidate. Height and weight protocols were also practiced, and data compared to ensure assessment accuracy.

4.4. Data Management

Survey data, organisation and company codes and measured height and weight were entered using Microsoft Excel. The two measures of height and weight were averaged. BMI (kg/m^2) was calculated as body weight (kg) divided by the square of height (m). PA MET levels were estimated by multiplying the MET score of an activity (MPA = 4.0 MET-mins/week; VPA = 8.0 MET-mins/week; walking = 3.3 MET-mins/week) by the duration of activities (minutes and days); summation of MPA, VPA and walking was used to estimate total MET-mins/week. [98] After cleaning the data, the file was imported to the Statistical Package for the Social Sciences (SPSS) version 25.0 for Mac.

Reported job descriptions were categorised as office workers, blue-collar and retail workers, while demographic variables were collapsed and coded as follows:

- Age: Two categories of 18 - 40 years, and >40 years;
- Education: Four categories of primary, high and secondary school, diploma and certificate, degree and higher degree;
- Fruit intake: Two categories of fruits (2+ and <2) servings per day;
- Vegetable intake: Two categories of vegetables (5+ and <5) servings per day;
- Alcohol intake: Two categories of standard - 1 or 2 drinks/day or >2 drinks/day
- BMI: Two categories of <25 kg/m^2 (normal/underweight), or ≥25 kg/m^2 (overweight/obese).

Total PA MET mins/week were dichotomised into categories of meeting the recommended PA guidelines (≥600 MET-mins/week), and not meeting these guidelines (<600 MET-mins/week). Total sitting time was categorised as high sitting vs low sitting using a median split for all participants, with high total sitting time being those participants reporting more than 7 hrs/day. This categorisation process was also used for OSPAQ data with participants classified as high occupational sitters if reporting more than the median value of 50% of work time spent sitting.

4.5. Statistical Analysis

Descriptive statistics for occupational groups were calculated for PA and SB data, sociodemographic characteristics, and health behaviours. A Kruskal Wallis-H test assessed differences between office, blue-collar and retail workers for total PA and SB (IPAQ; walking, MPA, VPA, total PA [MET-mins/week, and sitting [mins/week]), and work-related PA and SB (OSPAQ: Percentage of weekly work time spent sitting, standing, walking and in heavy labour).

The associations of meeting guidelines, reporting high total sitting time and high workplace sitting (OSPAQ) were analysed using logistic regression models. Unadjusted and adjusted odds ratios were reported. Adjusted models included the variables of BMI, age, education, gender and employment classification. Co-variates of smoking, fruit intake and alcohol were not included in the models as there was not a significant association between these and the primary outcomes. Meeting PA guidelines with dichotomous options (yes or no), high total and high work sitting variables were also included in the adjusted models if not the outcome variable of interest. P values were considered statistically significant in all analyses at $p<0.05$.

CHAPTER 5: RESULTS

5.1. Demographic Characteristics and Health Behaviours

A total of 402 participants consented to participate in this study, of whom two participants experienced difficulty comprehending items and therefore did not complete the survey. Two women who participated in the study identified that they were pregnant, and were excluded, resulting in 398 participants (n=190 men and n=208 women) being entered into the analyses. Office workers (n=213) were the largest occupational classification, followed by blue-collar (n=133), and then retail workers (n=52).

The demographic characteristics and health behaviours of these workers are presented in Table 1. Amongst office workers, there was an equal distribution of men (50%) and women (50%), and close to equal for blue-collar workers (men 56%, women 44%), but there was a higher percentage of women (83%) than men (17%) in the retail worker group. In relation to age, office workers were older (highest proportion between 41 - 60 years; 53%), and blue-collar and retail workers tended to be younger (highest proportion between 26 - 40 years; 48% and 56% respectively). Office workers were more highly educated, with more participants in this group completing a diploma or certificate (57%), or degree and higher degree (25%) than blue-collar (29%; 0%) or retail workers (11%; 8%) respectively.
A higher proportion of office workers (76%) were overweight or obese (>24.9 kg/m^2), compared to blue-collar (32%), and retail (21%) workers. Statistically-significant differences between job classification groups ($p<0.05$) were observed for all the demographic

characteristics of gender, age, qualifications, BMI and work status. The mean time spent working for occupational groups ranged between 36 - 38 hrs/week.

Table 1. Sample characteristics (frequency [%] or mean [SD]) relative to occupational group

		Job Classification Groups			
Characteristics	**Total n (%)**	**Office Workers n (%)**	**Blue-Collar Workers n (%)**	**Retail Workers n (%)**	**p for difference between groups**
Gender					
Male	190 (48%)	106 (50%)	75 (56%)	9 (17%)	.000
Female	208 (52%)	107 (50%)	58 (44%)	43 (83%)	
Age (years)					
18 – 25	48 (12%)	7 (3%)	25 (19%)	16 (31%)	.000
26 – 40	179 (45%)	86 (40%)	64 (48%)	29 (56%)	
41 – 60	162 (41%)	113 (53%)	42 (32%)	7 (13%)	
60 years and above	9 (2%)	7 (3%)	2 (1%)	-	
Education					
Primary school	55 (14%)	4 (2%)	46 (35%)	5 (10%)	.000
High & secondary school	119 (30%)	34 (16%)	48 (36%)	37 (71%)	
Diploma & certificate	167 (42%)	122 (57%)	39 (29%)	6 (11%)	
Degree or higher degree	57 (14%)	53 (25%)	-	4 (8%)	
Body Mass Index (kg/m^2)					
Underweight (<18.5 kg/m^2)	8 (2%)	5 (2%)	-	3 (6%)	.000
Normal range (<25 kg/m^2)	174 (44%)	46 (22%)	90 (68%)	38 (73%)	
Overweight (25 - 30 kg/m^2)	127 (32%)	86 (40%)	32 (24%)	9 (17%)	
Obese (>30 kg/m^2)	86 (22%)	73 (34%)	11 (8%)	2 (4%)	
Work Status					
Full time	367 (92%)	205(97%)	111 (84%)	51 (98%)	.000
Part time/Casual	30 (8%)	7 (3%)	22 (16%)	1 (2%)	
Work hrs/week mean (SD)	36.36 (6.2)	35.7 (6.7)	37.0 (6.1)	37.5 (4.7)	.159

Table 1 Continued.

Characteristics	Total n (%)	Office Workers n (%)	Blue-Collar Workers n (%)	Retail Workers n (%)	p for difference between groups
		Job Classification Groups			
Nutrition					
Vegetables (5+ serves/day)	397 (100%)	0 (0%)	0 (0%)	0 (0%)	
Fruits (2+ serves/day)	188 (47%)	82 (39%)	74 (56%)	32 (62%)	.001
Smoking					
Never smoked	235 (59%)	135 (63%)	68 (51%)	32 (62%)	.108
Previous smoker	15 (4%)	10 (5%)	4 (3%)	1 (2%)	
Smoker	148 (37%)	68 (32%)	61 (46%)	19 (36%)	
Alcohol					
Nil	172 (43%)	91 (43%)	53 (40%)	28 (54%)	.021
1-2 standard drinks/day	81 (20%)	50 (23%)	19 (14%)	12 (23%)	
>2 standard drinks/day	145 (37%)	72 (34%)	61 (46%)	12 (23%)	

In terms of health behaviours, no participants reported meeting the recommended intake of vegetables (5+ serves/day). Over half of blue-collar and retail workers met guidelines for fruit intake (2+serves/day), while the proportion meeting fruit intake guidelines in office workers was significantly lower (39%; $p<0.05$). Close to half of blue-collar workers reported smoking, although this proportion was not significantly different to the other worker classification groups. A non-significant, higher proportion of blue-collar workers (46%) consumed >2 standard drinks/day, compared to office (34%) and retail (23%) workers.

5.2. Physical Activity and Sitting Time (total and work)

Descriptive data for self-reported PA and sitting time by occupational groups are presented in Table 2. These data describe total PA and sitting time, as measured by the IPAQ, along with work hours in the week recalled, and percentages of work hours participants spent sitting, standing, walking and in heavy labour, as measured by the OSPAQ.

Table 2. Total and work-related (OSPAQ) self-reported PA and sitting time relative to occupational group

	Office Workers		Blue-Collar Workers		Retail Worker	
	Median	**25%, 75%**	**Median**	**25%, 75%**	**Median**	**25%, 75%**
International Physical Activity Questionnaire [67]						
Walking *(MET-mins/week)*	3465	2079, 5544	2772$^{\Delta}$	1386, 5544	4967	2512, 8316
MPA *(MET-mins/week)*	120	0, 720	240	0, 720	360	120, 720
VPA *(MET-mins/week)*	0*	0, 0	0	0, 480	0	0, 220
Total PA *(MET-mins/week)*	4238^{ŧ}	2471, 6644	4212	2316, 7965	5931	3132, 8757
Total Sitting time *(hrs/day)*	8*^{ŧ}	6, 10	6$^{\Delta}$	4, 8	4	3, 5
Occupational Sitting and Physical Activity Questionnaire (OSPAQ)						
Work hours *(hrs/week)*	35	31, 40	40	35, 40	40	35, 40
Sitting *(% weekly work time)*	60*^{ŧ}	40, 70	30$^{\Delta}$	10, 60	15	10, 20
Standing *(% weekly work time)*	20^{ŧ}	10, 25	20$^{\Delta}$	10, 29	40	26, 50
Walking *(% weekly work time)*	20	15, 30	20$^{\Delta}$	10, 30	25	20, 30
Heavy labour *(% weekly work time)*	0*^{ŧ}	0, 0	10	0, 30	10	0, 20

*office vs blue-collar workers; ^{ŧ}office vs retail workers; $^{\Delta}$blue vs retail workers; ($p<0.05$)

5.2.1. IPAQ Data

Self-reported total PA for all occupational groups showed a median of 4283 MET-mins/week. Most participants in all groups (97% office workers, 99% blue-collar, 98% retail workers) met the PA guidelines of >600 MET-mins/week. Retail workers were the most active occupational group (5931 MET-mins/week), with significant differences (p<0.05) observed for total PA (retail vs office workers; difference of 1693 MET-mins/week), and walking (retail vs blue -collar workers; difference of 2195 95 MET-mins/week).

The median total sitting time for all occupational groups was 7 hrs/day, with this threshold used to classify high (≥7 hrs/day) and low (<7 hrs/day) sitters. Office workers reported the highest self-reported total sitting time (median of 8 hrs/day), and 69% of this occupational group were classified as high sitters (n=136). This was significantly higher (p<0.05) than blue-collar workers (6 hrs/day; 35% [n=47] high sitters) and retail workers (4 hrs/day; 8% [n=4] high sitters).

5.2.2. OSPAQ Data

For all occupational groups, the median percentage of weekly work time spent sitting was 50%. Comparisons between groups indicated that the median percentage of time spent sitting at work was significantly higher (p<0.05) in office workers (60% of weekly work time), compared to blue-collar (30% of weekly work time) and retail workers (15% of weekly work time).

Retail workers spent twice as much time (40% vs 20%) standing at work than office or blue-collar workers ($p<0.05$). The median percentage weekly time spent walking was also significantly higher ($p<0.05$) in this group (25%), compared to blue-collar workers (20%). Lastly, office workers spent significantly less work time in heavy labour (0% of weekly work time) than both retail and blue-collar workers (10% of weekly work time for both groups; $p>0.05$).

5.2.3 Logistic Regression Analyses

Table 3 shows the unadjusted odds of meeting PA guidelines (IPAQ; >600 MET-mins/week), and being classified in high total (IPAQ; ≥7 hrs/day) and workplace sitting (OSPAQ; ≥50% of weekly work time) groups. No significant difference was observed for the odds of meeting PA guidelines. Blue-collar and retail workers were less likely to report high total and high work place sitting time ($p<0.05$) than office workers.

In adjusted analyses (Table 4), retail workers were significantly less likely to report high total sitting (OR = 0.06, 95% CI: 0.02 - 0.17) and workplace sitting (OR = 0.08, 95% CI: 0.02 -0.27), compared to the reference category of office workers ($p>0.05$). Similarly, blue-collar workers were less likely to report high total sitting time (OR = 0.43, 95% CI: 0.24 -0.79), with those reporting high workplace sitting time less likely to report low total sitting (OR = 0.06, 95% CI: 0.04 - 0.11). Participants ≥40 years of age were more likely to report high total sitting (OR = 1.70, 95% CI: 1.05 - 2.75), and workplace sitting (OR = 1.86, 95% CI: 1.13 - 3.05) than participants <40 years. No other demographic characteristics were associated with the odds of meeting PA guidelines, or reporting high total or workplace sitting.

Table 3. Logistic Regression (unadjusted) for Occupational Groups Physical Activity and Sitting Behaviour

	Meeting PA guidelines		**High Total Sitting (7hrs/day)**		**High Workplace-Sitting (>50% work hrs)**	
	OR (95%CI)	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Office Workers	ref		ref		ref	
Blue-Collar workers	1.73 (.21, 14.40)	.61	**.05 (.02, .14)**	.000	**.06 (.02, .19)**	.000
Retail Workers	2.23 (.46, 10.89)	.32	**.31 (.20, .49)**	.000	**.34 (.22, .55)**	.000

Table 4. Logistic Regression (adjusted) of meeting PA Guidelines and High Total Sitting (≥7 hrs/day) and at work (≥50% work hrs/day)

	Meeting PA guidelines		**High Total Sitting**		**High Workplace-Sitting**	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Classification						
Office workers	ref		ref		ref	
Blue-Collar Workers	3.95 (.29, 54.45)	.30	**.43 (.24, .79)**	**.01**	.54 (.28,1.04)	.07
Retail Workers	.23 (.01, 4.29)	.32	**.06 (.02, .17)**	**.00**	**.08 (.02, .27)**	**.00**
Gender						
Male	ref		ref		ref	
Female	2.54 (.58, 11.05)	.21	1.36 (.85, 2.19)	.20	1.54 (.95, 2.51)	.08
Age (years)						
18 - 40	ref		**ref**		**ref**	
41 - 60 years and above	.89 (.20, 3.93)	.88	**1.70 (1.05, 2.75)**	**.03**	**1.86 (1.13, 3.05)**	**.01**
Education						
Primary school	ref		ref		ref	
High & Secondary school	7.41 (.44, 124.79)	.16	1.05 (.49, 2.29)	.90	.80 (.35, 1.81)	.59
Diploma & Certificate	7.96 (.52, 135.68)	.15	1.06 (.48, 2.35)	.88	.68 (.29, 1.56)	.36
Degree or higher degree	10.85 (.45, 135.68)	.14	2.20 (.77, 6.16)	.13	2.56 (.90, 7.27)	.08

Table 4 continued

	Meeting PA guidelines		High Total Sitting		High Workplace-Sitting	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Body Mass Index (kg/m^2)						
Normal or underweight	ref		ref			
Overweight or obese	.53 (.12, 2.27)	.39	1.05 (.60, 1.84)	.86	1.59 (.91, 2.76)	.10
Sitting Time						
High sitting time	ref		-	-	ref	
Low sitting time	10.11 (0.65, 156.98)	.09	-		**.06 (.04, .11)**	**.000**
Physical Activity						
Meets PA guidelines	-	-	-	-	ref	
Does not meet PA guidelines					1.68 (.24, 11.92)	.60

CHAPTER 6: DISCUSSION

6.1. Overview of Findings

While levels of PA and SB have been well reported in working adults from higher income, developed countries, data for lower income, developing countries is less well reported. [81] This study is first to assess PA and SB levels within varied working groups (office, blue-collar and retail) in PNG, a rapidly industrialising nation in the Pacific region. Validated questionnaires (the IPAQ and OSPAQ) were used to collect self-reported PA and SB during work hours and over the whole day, in addition to survey items that assessed other lifestyle behaviours (e.g. smoking and diet), as well as demographic characteristics (e.g. occupation and educational status).

The findings showed that the large majority of participants met PA guidelines, with PA accrued mostly through walking. Retail workers were the most active occupational group. Office workers reported higher (total and work) sitting time compared to blue collar and retail workers. Further to this, logistic regression analyses indicated that compared to office workers, blue-collar and retail workers were less likely to report high levels of total and workplace sitting time. Work place sitting was related to total sitting time, while older workers (>40 years) were also more likely to sit for more than 7 hrs/day, and spend 50% of work time sitting.

6.2. Prevalence of Total PA and SB

Comparisons with other PNG and lower income, developing country self-reported studies indicate lower levels of total PA than the current study. For example, a population wide WHO STEPS risk factor survey for NCDs in PNG (n = 2944) reported 76% men and 70% women were physically active (>1500 MET mins/week). [115] In this study, work-related PA accounted for the highest PA during the day. Similarly, a recent study by Rarau and colleagues [120] reported a 34% physical inactivity rate (>75 or 150 mins/week on VPA and MPA respectively) in PNG adults (n = 772), with inactivity rates relatively less prevalent in PNG than in other Pacific regions (>50%). In the most comprehensive overview of PA levels worldwide, an IPAQ study [121] with a pooled sample of participants (n=300,000) from 76 low and middle income countries reported that four in five adults meet recommended levels of PA (>600 MET mins/week). Particular studies from developing countries show a wide variation in PA rates with a study from Mozambique (n = 3190) finding 96% of adults achieving guidelines (<75 or 150 mins/week on VPA and MPA) [103] and one from Cuba (n = 5618), [99] reporting that 71% participants achieved PA recommendations (>600 MET mins/week).

Possible reasons for the higher levels of PA participation found in the present study may include variations in the self-report measures used, subjective interpretations of the survey items by participants with different educational backgrounds, [67] as well as the criteria applied by researchers to assess PA rates (i.e. a threshold of 600, compared to 1500 MET mins/week). Importantly, the sample used in the present study was smaller (n = 398), and less representative of the general population than that used in other studies which may have resulted in higher levels of PA. Indeed, the focus on targeting workers in different occupational sectors, while a strength, limits comparability with overall population data. However, regardless of the differences highlighted, the findings of this and other studies highlight higher levels of total PA participation in adults from developing as opposed to developed countries. Studies from France, the UK, US and Australia indicated that <50% of participants did not achieve the recommended levels of self-reported PA. [55, 122, 123]

While there is a clear lack of SB data for PNG, the findings suggest that overall, the workers who participated in this study reported high levels of sitting of 7hrs/day. The 20 country IPAQ study by Bauman et al., [9] which used data from both developed and developing countries, showed a median total sitting time of 5 hrs/day. Developing countries included in the study tended to show lower median sitting times (Brazil and Columbia 3hrs/day; India 3.5 hrs/day; China 4hrs/day and Argentina 5 hrs/day). [9] The high total sitting time found in PNG workers is also reflective of those reported in workers from developed countries. For example, a median total sitting time of 7 hrs/day was the same as that found by Jans et al.,[21] in a Dutch working population.

6.3. PA and SB in different Occupational Groups

Studies in developing countries have reported that occupational PA was the main contributor to total PA, [93, 97, 100, 101] although studies in these countries have yet to examine occupational PA contributions for different occupational groups. A main aim of the present study was to examine this question, and while a large proportion of workers met guidelines, PA levels were found to vary across occupations. This was not due to MPA or VPA, which were similar across worker groups. However, walking contributed to a significantly higher volume of MET-mins/week for retail and blue-collar workers compared to office workers. Possible reasons for this may include that jobs within the blue-collar and retail sectors in PNG still involve a number of movement-related tasks, while PNG's high crime rate and concerns over safety may have prevented active transport in white collar office workers, who tend to be from higher SES groups and use motorised transport. [102]

For SB, the study findings showed significantly higher total and work-related sitting times in office compared to blue-collar and retail workers. Sitting time in work groups has not been well studied in developing countries, but the findings of this thesis concur with those observed in developed countries. Studies from Australia and the Netherlands have shown that blue-collar and/or trade service workers sat less compared to professional, desk-based workers, with mean differences of >2 hrs/day and >4 hrs/day respectively. [21, 88]

The sample of office workers studied here also reported higher educational status compared to blue-collar and retail workers, and this is consistent with findings from the epidemiological study by Bauman et al., [9] from both developed and developing countries. The study by Bauman et al.,[9] used IPAQ and showed that sitting time was higher (median ≥6 hrs/day) for those who attended >13 years of post-school education than those who spent less time in education (<3 hrs/day). In a developing country study using IPAQ-M with Malaysian employees, highly educated adults sat for 7.6 ± 2.4 hrs/day, while those with a lower educational status sat for 7.2 ± 2.5 hrs/day, although no significant difference was found for sitting time. [89]

While the OSPAQ has been used to assess workplace sitting, standing and PA in developed countries it has not been used in developing countries to evaluate behavioural patterns in different occupational groups. The data presented in this thesis is therefore novel and useful in beginning to identify those most in need of intervention in PNG. Participants spent an average of 35 - 38 hrs/week at work, with the highest percentage of workplace time spent standing (40%) and walking (25%) demonstrated by retail workers; both blue-collar and retail workers spent less time (10%) in heavy lifting. Logistic regression evidenced that sitting time was likely to be higher amongst PNG office workers. Reflecting a similar pattern to OSPAQ data collected in developed countries, [123] office workers may therefore be a priority work group for targeted action on SB in PNG. Indeed, an overall sitting time of ≥6.2 hrs/day was shown to account for 3.8% of all-cause mortality in Western Pacific nations, including developed (Australia) and developing (Micronesia) countries. [11]

Although the interactive effect of PA, sitting and health outcomes is under debate and controversial,[10] the need to target sitting in high risk groups is important for health promotion. A recent meta-analysis of SB studies with over a million participants reported that high total sitting time (6 - 8hrs/day) resulted in a higher risk of all-cause, CVD mortality and type 2 diabetes incidence. [10] This risk is attenuated by engaging in PA but at levels higher than current PA guidelines (high levels of MPA of 60 – 75 mins/day). Given that the study sample were highly active, these health risks may be of less concern for a section of PNG workers. However, little is known about the health risks of SB and PA in the PNG population specifically, which highlights the need for ongoing research into the combined impact of PA and SB on the health of PNG workers.

6.4. Other Lifestyle Behaviours and Demographic Characteristics

An evaluation of other behavioural risk factors in PNG adults (e.g. diet, BMI, and smoking), indicated that consumption of fruits and vegetables was below recommended levels for health. [115] In the present study, none of the workers met recommended consumption levels for vegetables (0%) compared to fruits (39% office workers; 56% blue-collar workers; 62% retail workers). The prevalence of smoking was found to be less than earlier studies (overall 37% compared to 41-47%). [115, 120] Alcohol consumption of more than 2 standard drinks/day was also found to be lower amongst all workers (34%), compared to previous PNG data (43%). [120]

As with other studies that examined the association between educational attainment and occupation, [23, 91, 93, 94, 102, 106] the findings presented in this thesis, showed office workers possessed a higher educational level, and were from an older age group (41 - 60 years). Similar to findings reported in an Australian sample, [88] these workers also had a higher prevalence of BMI ≥29 kg/m^2 (35% in office workers compared to 12% for blue-collar and retail workers), with age and volume of sitting potential interactive contributors. Analyses showed an association with age and high total and work sitting time. This was in agreement with earlier studies reporting relationships between older age and higher sitting time. [81, 94-96, 98, 99, 101]

6.5. Implications for Future Public Health Research and Policy

The findings presented in this thesis indicate that samples of PNG urban workers were mostly achieving PA guidelines, particularly through walking. A key aim of the study was to investigate differences between office, blue-collar and retail workers; PNG retail workers were the most active group, while office workers were more sedentary, both overall and at work. Given the high levels of NCDs and rapid lifestyle changes in PNG, there is a clear need to develop public awareness of the benefits of being active and reducing sitting in all occupational groups. That said, the data from the current study suggests that PNG office workers, and those in middle-to-older age categories, are a priority group. Existing interventions for office workers in developed countries include screen-based point of choice prompts to promote sitting breaks, [124] sit-stand work stations, [12] and educational and organisational health programs. [125] These interventions should be trialled in developing countries such as PNG, and may assist in preventing the risk of developing NCD's. Particular attention would need to be paid to adapting strategies that reflect the socio-cultural requirements of PNG office workers, and similar to programs in Australia, [17] this may begin with qualitative research that captures the views, experiences and needs of these workers.

The National Health Plan [27] aimed to promote healthy lifestyles in PNG and to reduce morbidity and mortality from NCD's includes population-based health interventions to promote PA and improve diet. The present study contributes evidence as to the levels of PA and SB in groups of urban working adults, highlighting that the national plan should consider including action that targets SB. Furthermore, continued promotion of PA should also be targeted, with attention given to maintaining walking levels, but also promoting higher intensity activities; physical activities that raise heart rate to moderate and vigorous intensities have particular benefits for cardiovascular function, heart disease [51] and associated conditions such as obesity and type 2 diabetes, a growing health concern in PNG [120] and Pacific island countries. [114] In developed countries, promotion of leisure time activities has been suggested as a potential means of compensating for reduced PA and increased SB in other domains of life. [126] This may be difficult to achieve in developing countries such as PNG, due to issues linked to affordability, access, time and safety. [102]

Indeed, implementing population strategies that effectively promote PA and reduce high levels of SB in PNG will be challenging. Large scale industrialisation and urbanisation has led to unsafe environments for walking, and poor access to exercise locations, with increasing crime rates and high levels of vehicle use for transportation drastically reducing PA. Concurrently, technology advancement is increasing levels of SB during occupational time, thereby further reducing opportunities for PA during job tasks. Moving forward, there is an urgent need for concerted, multi-sectoral action that engages stakeholders that includes individual workers, companies, government organisations and policy makers. These health promotion strategies must develop and integrate creative movement solutions that account for the needs of different working groups in a rapidly changing industrialised environment.

6.6. Study Strengths and Limitations

The size of the organisations recruited varied from small to large companies, which impacted the uptake of participants into the study. However, the strengths of this study included a relatively large sample size of workers, with participants recruited and categorised for analyses into three distinct occupational groups. Evaluation of office, blue-collar and retail workers was a particular study strength given the significant challenges involved in recruiting participants and collecting data. For example, participants worked in a wide variety of locations, while coordinating logistics for data collection during work schedules needed to be carefully managed. Furthermore, data was collected from various public and private organisations, within a short time frame.

Measures included standardised, reliable and validated self-report survey items, which were piloted prior to interviewer administration with the full sample. Use of the IPAQ and OSPAQ in combination allowed investigation into both total and work-related behaviours in different types of worker groups. The IPAQ specifically has been comprehensively used in many studies across the world, which allowed the data for this PNG sample to be compared to other samples from different countries. [127] Indeed, the survey has been tested in both developed and developing countries and is highly recommended for use with developing country urban populations. [128] The OSPAQ has been less extensively used, and then only in a developed country context. The present study is therefore novel as a starting point for use of this survey as a measurement tool for diverse populations of adults in developing countries such as PNG.

The use of a self-report, interview administered survey also had limitations. While the research team were trained in the administration of the surveys, and every effort made to standardise measures, worker recall bias may have inflated PA estimates and underestimated SB findings. [91] This may have contributed to the high PA levels found in the thesis sample, especially for walking, although it could also be argued that very high levels of walking are unavoidable for certain types of PNG workers. While piloting also enabled the research team to adapt to the needs and contexts of participants, limited understanding of some of the survey items by lower educated workers in the sample may have impacted the accuracy of the data collected.

In terms of analyses, use of a standard threshold of 600 MET-mins/week resulted in most of the participants meeting PA guidelines; use of a higher threshold indicative of higher volumes of PA for this active sample (e.g. 1500 MET-mins/week) may have benefited regression analyses. Also following the standard guidelines of 5+ servings of recommended vegetables resulted in none of the participants meeting the recommended levels; lowering the threshold may have assisted in evaluating healthier and less healthy groups (e.g. 2+ serves/day).

Future studies with PNG workers should consider adding to the data presented in this thesis by using objective PA and SB measures, such as accelerometers. Although too long for use in the present study, a survey tool like the GPAQ, which has been recommended for use with low socioeconomic countries, [9] may also be advantageous, particularly because this survey provides domain specific data on PA at work, and during transport and leisure time.

While the cross-sectional study design used by the present study was appropriate to investigate correlates of PA and SB in different occupational groups from PNG, the design limits conclusions concerning causality. [18, 94] Additionally, until more research is undertaken with larger groups from across PNG, the findings cannot be generalised to the PNG population as a whole. While industrialisation is occurring rapidly, most PNGuineans are subsistence farmers, with 87% living in rural areas, and only 13% in urban areas. [115] Lastly, beyond BMI and lifestyle behaviours such as PA, SB, smoking and alcohol consumption, the study did not identify any metabolic health indicators, or disease risk factors such as hypertension or cardio-vascular fitness.

6.7. Key Recommendations

The current findings together with the previous recommendations of studies from PNG suggests that reducing risks for NCD's must be a national priority and that development of strategies to prevent and manage the potential risks should be undertaken. [115] To inform this process, a large prospective cohort study of the diverse population in PNG examining the behavioural health risks for NCDs (incorporating objective measures) and the resultant health markers would provide better evidence of the risks posed to the whole population.[100] Other elements of PA may also need further research in developing countries such as muscle strengthening activities. [33] Lastly, using the framework of reach, effectiveness, adoption, implementation and maintenance, testing of 'sit less, move more' interventions for office based workers in developed countries is well underway. [129, 130] A key recommendation emerging from this thesis is for researchers, practitioners, and policy makers to apply and adapt this knowledge base and research process to PNG occupational groups.

6.8. Conclusions

This thesis explored self-reported levels and correlates of PA and SB in different occupational groups from PNG. A detailed literature review identified a limited PA and SB evidence base for workers from developing countries, and identified the need for the present cross-sectional study in PNG workers.

The findings showed that overall, most workers in the urban-based sample recruited to the study met standard PA recommendations. Walking made the highest contributions to PA levels, while retail workers were the most active occupational group. The highest levels of SB, both total and at work, were found amongst office workers. Age was found to be a key correlate of sitting, whereby older workers had an increased risk of higher levels of SB than younger workers.

Implications for practice included the need to target SB intervention strategies in PNG office workers, while continuing awareness raising campaigns of PA benefits in all occupational groups. Specific study strengths were analyses of data for different types of PNG workers, and the use of validated and widely used self-report measures. Self-report was also a limitation with potential recall error and bias to be considered. Future directions for research identified the value of adding to the data collected in this thesis through objective measures of PA and SB. Additionally, a nationwide study of health risks and behaviours, to include PA and SB, is needed to inform effective health promotion in the diverse working population of PNG.

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APPENDICES

Appendix A – TABLES FOR LITERATURE REVIEW

Table 5. Aims and characteristics of included studies

Authors	Study Aim	Participants/Country	Study Description
Atkinson et al., [91]	To assess relationships between country level variables (urbanisation, and economic/human development), occupational category and physical inactivity.	n = 196,742 (62,522 men and 134,219 women). Age range = 18 to 69 years. 47 low or middle-income countries.	A cross-sectional study (World Health Survey 2002-2003), examining associations between country level factors, occupational status and self-reported physical inactivity (adjusted for occupation).
Howitt et al., [93]	To estimate levels of PA and SB in young to middle-aged adults.	n = 354, (138 men and 216 women). Age range = 25 to 54 years. Barbados.	A representative cross-sectional study (Health of the Nation Survey), assessing self-reported and objective activity using combined HR and movement sensing, determined PA/SB at home & work, and during transport and leisure.
Kirunda et al., [94]	To determine PA patterns or levels and factors associated with SB and physical inactivity.	n = 1208, (603 men and 605 women). Age range = 18 to ≥ 65 years. Uganda.	A population-based, cross-sectional study (Iganga-Mayuge Health and Demographic Surveillance Site, 2005-13) that assessed accelerometer-determined PA and SB.
Tilahun Nigatu Haregu et al., [95]	To describe levels of PA and SB in urban slum setting.	n = 5190, (2794 men and 2396 women). Age range = 18 to ≥ 60 years. Nairobi, Kenya.	A population-based, cross-sectional study (Nairobi Urban Health and Demographic Surveillance System, 2008-09), assessing self-reported PA during work, transport and recreation, and time spent sitting and sleeping.
Oguoma et al., [96]	To assess levels of PA and associations with the metabolic syndrome and risk factors in a rural population.	n = 417, (145 men and 272 women). Age = ≥ 18 years. Nigeria.	A cross-sectional study (Prediabetes and Cardiovascular Complications Study), measuring self-reported participation in MVPA and SB at work, and during travel, and recreation/sports.

Table 5. Continued

Authors	Study Aim	Participants/Country	Study Description
Varona-Perez et al., [99]	To describe the patterns of, and factors associated with PA.	n = 7915, (4037 men and 3878 women). Age range = 15 to 69 years. Cuba.	A descriptive cross-sectional study (the Third National Survey on Risk Factors and Non-Communicable Chronic Diseases, 2010-2011), assessing self-reported PA and SB at home and work, and during transport and leisure.
Assah et al., [105]	To understand the patterns of PAEE and its associated intensity distribution of SB and in moderate-vigorous PA.	n = 544, (199 men and 345 women). Age range = 25 to 55 years. Cameroon.	A population-based cross-sectional study, measured PA using combined heart rate and movement sensor and self-reported socio-demographic, were used to correlate patterns of PA.
Anjana et al., [97]	To assess the impact of economic growth and development on levels of PA.	n = 14,227 (men 6627 and 7600 women). Age range = ≥20 years. India.	A cross-sectional study, national survey (Indian Council of Medical Research-India Diabetes, Phase I), assessing self-reported work, transport and leisure-related PA.
Ng et al., [107]	To investigate the changes in PA distributions resulted due to significant changes in social and economic factors.	n = 12,777, (men and women). Age range = 18 to 60 years. China.	A large-scale longitudinal study (Child Health and Nutrition Survey 1991-2011), which estimated PA in the four domains of occupation, domestic, travel and leisure.
Teh et al., [98]	To investigate the sociodemographic factors influencing PA	n = 19,251. (8969 men and 10,176 women). Age range = 16 years and above. Malaysia.	A cross-sectional population survey (the Malaysian National Health and Morbidity Survey 2011); interviews assessed PA in the domains of work, transportation, leisure time and home/gardening.
Vaidya and Krettek [101]	To determine the relationship between PA and other behavioural and biological risk factors for cardio metabolic diseases amongst urban population.	n = 640, (145 men and 465 women). Age range = 25 to 59 years. Nepal.	A cross-sectional study (Jhakhel-Duwakot Health Demographic Surveillance Site 2011), that assessed self-reported PA levels at work, and during travel and leisure.

Table 5. Continued

Authors	Study Aim	Participants/Country	Study Description
Venguia et al., [102]	To investigate associations between demographic characteristics, socioeconomic status and PA patterns.	n = 80, (31 men and 39 women). Age range = 18 to 65 years. Papua New Guinea.	A cross-sectional study (conducted in 2010), administered interview and reported on PA patterns with METs of walking, MPA and VPA.
Chu and Moy [100]	To investigate PA patterns and associations with risk factors for the metabolic syndrome.	n = 686, (272 men and 414 women). Age range = ≥35 years. Malaysia.	An analytical cross-sectional study (2010-11), that assessed self-reported PA during work, transport, at home and during leisure time. The study also reported on associations between PA, metabolic risk factors, and obesity.
Chu and Moy [89]	To examine associations between sitting time and PA with metabolic risk factors among middle aged adults.	n = 686, (272 men and 414 women) Age range = ≥35 years. Malaysia.	A cross-sectional study (2010-11), that assessed self-reported PA and sitting time at work, home and during travel, and the prevalence of metabolic syndrome.
Padrao et al., [103]	To assess the socio-demographic determinants of PA.	n = 3211 (men and women) Age range = 25 to 64 years. Mozambique.	A community based cross-sectional study (World Health Organisation Stepwise Approach to Chronic Disease Risk Factor Surveillance [STEPS]-2005), assessing self-reported PA levels (low, moderate, high intensity) and SB at work, and during transport and recreation.
Bauman et al., [9]	To examine differences in sitting time between countries.	n= 49,493 (men and women). Age range = 18 to 65 years. 20 countries (Argentina, Australia, Belgium, Brazil, Canada, China, Columbia, Czech Republic, Hong Kong, India, Japan, Lithuania, New Zealand, Norway, Portugal, Saudi Arabia, Spain, Sweden, Taiwan, US).	A large-scale representative population study from 20 countries (International Prevalence Study 2002-04) that assessed self-reported daily or high sitting time.

VPA – Vigorous Physical Activity

Table 5. Continued

Authors	Study Aim	Participants/Country	Study Description
Bauman et al., [112]	To examine the socioeconomic differences and patterns of PA in developing countries in the Asia-Pacific region.	n=173,206 (78308 men and 93680 women) Age range = ≥35 years. China, Fiji, Nauru, Philippines, Malaysia and Australia.	A series of cross-sectional analyses of data from national surveys of countries (World Health Organisation 2002-06), that measured self-reported PA patterns at work, and during travel and leisure time, and how these patterns varied relative to sociodemographic status and population size.
Pronk et al., [108]	To assess PA in occupational and non-occupational time and risk of breast cancer.	n = 73,049 (women aged 40 - 70 years). China.	Self-reported data was used from Shanghai Women's Health Study, a population based prospective cohort study (1996-2000), to estimate associations with types and intensities of PA, and exposure of risk of breast cancer.
Rombaldi et al., [104]	To explore if leisure-time PA is associated with PA participation during work, at home and during transport.	n = 972, (418 men and 554 women). Age range = 20 to 69 years. Southern Brazil.	A population-based cross-sectional study (2006), assessing participation and associations between leisure-time PA, and occupational, housework, and transport-related PA.
Florindo et al., [106]	To estimate levels of PA and identify the factors associated (sex, age, skin colour, partner status, education,BMI, self-reported health status and smoking) with participation at work, and during transport, leisure and household settings.	n = 1318, (652 men and 666 women). Age range = 18 to 65 years. São Paulo, Brazil.	A representative cross-sectional, descriptive epidemiological study (Health Survey of the Municipality of São Paulo, 2003), assessing self-reported PA in different domains

Table 5. Continued

Authors	Study Aim	Participants/Country	Study Description
Gregory et al.' [109]	To describe PA patterns and distributions of daily energy expenditure.	n = 1804, (819 men and 985 women). Age range = ≥ 31 years. Guatemala.	A prospective study (Institute of Nutrition of Central America and Panama, 2002-04), assessing overall self-reported PA levels and EE during work, transport, domestic chores and leisure time.
Monda et al., [90]	To assess associations between weight, energy expenditure and occupational/domestic PA.	n = 9405, (4708 men and 4697 women). Age range = 18 to 55 years. China.	A population-based longitudinal survey (the China Health and Nutrition Survey 1991-2000), assessing overweight and obesity prevalence, and relationships between EE and PA at work and home.
Zhang et al., [110]	To examine the effects of SB on the risk of epithelial ovarian cancer.	n = 254 women with confirmed ovarian cancer and 652 controls with or without ovarian cancer. Age range = 45 ≥ 65 years. China.	A hospital-based case control study (1999-2000), assessed using a validated questionnaire of occupational and leisure-time sitting, and the risk of developing epithelial ovarian cancer.
Yamauchi et al., [111]	To investigate and compare (rural and urban migrants) the patterns of PA levels, intensity and overall PA level	n = 56, (29 men and 27 women). Age range = 20 to ≥ 40 years. Papua New Guinea (PNG).	A comparative study was conducted in two periods (1994 and 1995), using HR portable monitor and open-circuit indirect calorimetry measured daily PAL, physical exertion and TEE represents the sleep, sedentary and active) during occupational activities.

PAL - PA level, TEE – Total Energy Expenditure

PAEE - Physical Activity Energy Expenditure

Table 6. Measures, study outcomes, and conclusions of selected studies

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Atkinson et al., [91]	Cross-sectional survey including the IPAQ short form. Inactive = <600 MET-mins/week. Associations between inactivity and occupational status (multilevel logistic regression).	Overall prevalence of physical inactivity was 24%. Compared to those working in agriculture, white collar workers were 84%, (OR: 1.84, CI: 1.73-1.95), and other blue-collar workers 45%, (OR: 1.45, CI: 1.36-1.53) more likely to be inactive.	In countries experiencing economic development, shift from agricultural to industrial practices decreases PA.
Howitt et al., [93]	Cross-sectional survey & objectively assessed sedentary time and PA (Actiheart accelerometer) over 7 days. Median PA energy expenditure (KJ/kg/day), sedentary time (hrs/day), light intensity PA (hrs/day) & MVPA (mins/day). Associations between energy expenditure, & sedentary/PA time, educational level and occupational grade (multivariable regression models)	Objective estimated median of PA components were PAEE 40.9 kJ/kg/day, sedentary time of 8 hrs/day, LPA 6.7 hrs/day and MVPA 62.5 mins/day. Those with a higher education (i.e. graduates), were less active, and more sedentary than those with a lower education (i.e. not completed school); e.g. PA energy expenditure: Regression coefficient -1.8, (CI: -4.6 to -0.9). Those in a higher-grade occupation (i.e. professional), were less active, and more sedentary, than those in a lower grade occupation (manual workers); e.g. sedentary time: Regression coefficient 0.5, (CI: 0.1 to 0.8).	Education and occupation are strong influences on sedentary time and PA in Caribbean adults.
Kirunda et al., [94]	A semi structured questionnaire, with PA assessed using Isport the W181 wrist 3 Axis Sensor Accelerometer Silicon Pedometer Watch (7 days wear). PA (steps/day) – sedentary (<5000 steps/day), low active (5000-7499 steps/day), somewhat active (7500-9999 steps/day), active (10,000-12,499 steps/day), and highly active (≥12500 steps/day). Factors associated with SB and physical inactivity (logistic regression).	Mean PA was 9855 steps/day; Participants were 19% sedentary, 19% low active, 18% somewhat active; 17% active; 28% highly active. Urban residents were engaged in less physically active occupations, and used more motorised transportation, compared to those who worked in labour intensive occupations (agriculture), in rural areas.	SB and physical inactivity were highest in urban participants, hence specific PA interventions targeting urban occupational groups need to be promoted for Eastern Ugandan population

Table 6. Continued

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Tilahun Nigatu Haregu et al., [95]	General survey included structured questionnaire, based on STEPwise protocol and GPAQ with show cards. MPA in work/leisure/transportation (150 MET-mins/week), VPA in work/leisure/transportation (75 MET-mins/week) Insufficient PA (<600 MET-mins/week = MPA & VPA). PA patterns and associated factors of sitting, sleeping time and insufficient activity (Pearson correlation and logistic regression).	Mean MPA = 12.3 hrs/week; mean VPA = 5.8 hrs/week at work. Compared to active participants (MVPA = 13%), those who were physically inactive (14%) were more likely to be higher sitters (3.81; CI: 3.65-3.98 hrs, p<.05). Those with no formal education were 1.4 times more likely to be inactive, when compared to formally educated participants.	Developing road networks to encourage activities like walking, and travel to work are required to reduce sitting time. Also, low educated Kenyans are a high priority for intervention.
Oguoma et al., [96]	Survey with rural population, included GPAQ to assess PA, along with anthropometric measurement and biomedical parameters. MPA and VPA at work, during recreation/sports, and travel (MET-mins/week). Physically inactive <600 MET-mins/week Physically active ≥600 MET-mins/week Extent to which PA and inactivity predicted the metabolic syndrome and associated risk factors (logistic regression).	Overall 50% of participants were physically active, rural participants were active (60%) than urban (21%). Those with metabolic syndrome risk factors were highly physically active (OR: 1.48, CI: 0.71-3.09 METs) compared to inactive prediabetic (OR: 1.69, CI: 0.62-4.61) and diabetic (OR: 1.91, CI: 0.65-5.63) participants. Most participants were engaged in active transport (n = 220, mean 247.5±261.7 MET-mins/week) but less were involved in work related MPA (n = 165, 2644.4±3982.4 MET-mins/week) and VPA (n= 86, 8649.2±9253.8 MET-mins/week), also MPA during sports (n = 86, 740.3±1202.6 MET-mins/week). Farmers (54%) and students (66%) were more active than other occupational groups (p<0.0001).	Health education on PA benefits is needed with rural Nigerian population.
Varona-Perez et al., [99]	A national survey, which included the IPAQ short form. Active = 30 mins/day (MPA) or 10 mins for 5 days or more in a week; 20 mins (VPA) for 3 days or more in a week. Irregularly active = MPA or VPA for at least 10 mins/day Sedentary = no MPA or VPA for at least 10 mins in the last 7 days. Factors associated with SB and physical inactivity (multinominal logistic regression model).	Participants were 71% active, 6% irregularly active and 23% sedentary. Active occupational groups were self-employed (81%), and students (80%), whilst physical inactivity was high amongst home makers (11%) and retirees (9%). Participants with no formal education were least active (52%) and more sedentary (39%) compared to other educated participants.	Cubans with no formal education require strategies to promote PA and reduce SB.

Table 6. Continued

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Assah et al., [105]	Heart rate and movement sensors (Actiheart). MVPA = 150 mins/week of least 10 mins bout Sedentary = <1.5 MET, LPA = 1.5-3 MET, MVPA = >3 MET. Occupational activity intensities = light, moderate and intense. Associations between sociodemographic variables and PAEE or MVPA (multivariate logistic regression models).	Rural participants were more active (mean±SD: 58±23.2 vs 42.9±20.4 kJ/kg/day, $p<0.001$) and spent more time in MVPA (44 mins/day) and less time in SB (103 mins/day) than urban dwellers. Rural participants in moderate and intense occupations had higher PAEE ($p<0.001$) than those in light intensity occupations. Urban participants in intense occupations had higher PAEE levels ($p<0.001$). Time spent in MVPA with intense occupations ($p<0.001$) was significant with both rural and urban dwellers.	Growing urbanisation highlighted the importance of educating the Sub-Saharan Africans in improving and maintaining PA levels with urban participants.
Anjana et al., [97]	A large ongoing community-based survey, that included GPAQ and living locations (3 states and a union territory in India). Domains: MPA at work/leisure/transportation (150 MET-mins/week), VPA at work/leisure time/transportation (75 MET-mins/week) and insufficient PA (<600 MET-mins/week = MPA & VPA) Sub domains: Inactive/low active = <600 MET-mins), Active = (600-1200 MET-mins) Highly active = >1200 MET-mins). One-way ANOVA compared means between the above-mentioned groups.	Physical inactivity was higher in urban compared to rural participants (65% vs. 50%, $p<0.001$). Rural participants were more active (34%), and highly active (16%) as compared to urban participants (26% and 9%). Occupational PA accounted for most daily PA (46 mins/day of MPA and VPA).	High levels of physical inactivity were observed in all the surveyed regions. While occupational PA was the major contributor to overall PA, initiatives to promote leisure time PA are needed in India.

GPAQ – Global Physical Activity Questionnaire

Table 6. Continued

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Ng et al., [107]	Multiple surveys, were collected using questionnaires over time from 1991-2011 (nine provinces and three megacities). MET hrs/week were calculated for domains of PA (occupation, domestic, active leisure and travel and hrs/week in sedentary leisure time). PA at survey time points, and regression analyses for relationships with socio-economic factors.	A decline in overall PA, over 20 years due to occupational PA transition for men from 382 MET hrs/week to 264 MET hrs/week, and women from 420 MET hrs/week to 243 MET hrs/week. Urbanisation resulted in lower occupational PA for men and women (unadjusted mean 382.05 MET hrs/week and 419.96 MET hrs/week) respectively. Participants with lower education levels and lower income status experienced higher occupational PA (75th percentile of -5.02 (0.30), -7.50 (0.42) and 90th percentile of -6.02 (0.23), -11.02 (0.91)	Urbanisation and longitudinal decline in occupational PA in China indicate a need to develop interventions and policies to promote active leisure and travel.
Teh et al., [98]	Health survey including IPAQ short form. MET-mins/week calculated for the past 7 days. MPA, VPA, and walking was calculated by the duration in mins/hr spent in a day x number of days/week, and total PA = walking + MPA/VPA x 7 days of at least 600 MET-mins/week; sitting = duration/ min/hr during week day. Levels of PA and correlates with demographic variables (multivariate logistic regression).	64% of Malaysians were classified as active Self-employed workers were most active (74%) compared to other occupations (Government/semi Government 65%, private 67%, home maker 65% and retiree 48%). Higher socio-economic status participants were least active (63%) compared to other income status groups.	Higher socio-economic groups are a priority intervention target in Malaysia in planning and promoting PA.
Vaidya and Krettek [101]	A cross-sectional study that used GPAQ. Moderate and vigorous PA at work, walking or cycling for at least 10 mins commute to work, market etc., leisure = MPA and VPA (MET-mins/week). MET-mins/week – high, moderate and low. MPA = 150 mins/week and VPA = 75 mins of aerobic PA. Unadjusted and adjusted odds ratios for low PA compared to a combination of MVPA, and relationships with sociodemographic variables (Spearman's correlation coefficient).	High prevalence of low PA (43%) predominated among urban participants. Work-related PA (median 384 MET-mins/week) highly contributed to total PA (median 456 MET-mins/week). Occupational PA with agriculture was higher (median 576 MET-mins/week) as compared to other occupations such as government and nongovernment, self-employed and housewife. Those with high school education (51% men and 70% women) were three times more physically inactive than those with an informal education.	Growing urbanisation resulted in decline of overall PA. Multisectoral approach is required to improve PA levels for Nepalese population.

Table 6. Continued

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Venguia et al., [102]	A cross-sectional study that used the IPAQ short form. MET-mins/week calculated for the past 7 days. MPA, VPA, and walking were calculated by the duration in mins/hr spent in a day x number of days/week, and total PA = walking + MPA/VPA x 7 days of at least 600 MET-mins/week; sitting = duration/ min/hr during week day. Associations between demographic variables and walking-related and moderate/vigorous MET-mins (regression model).	All participants did not meet the recommended levels of PA. Socio-economic status, was negatively correlated with MET-mins for walking (p=0.02) but not correlated with MPA and VPA.	Walkability should be encouraged with high socio-economic groups amongst Papua New Guineans.
Chu and Moy [100]	A survey that used IPAQ- Malay version, long form. MET-mins/week calculated for the past 7 days. MPA, VPA, and walking was calculated by the duration in mins/hr spent in a day x number of days/week, and total PA = walking + MPA/VPA x 7 days of at least 600 MET-mins/week, sitting = duration/ min/hr during week day. Total PA was categorised into low, medium and high tertiles. With the high activity tertile as reference, logistic regression was estimated for PA for metabolic risk factors.	Occupational PA (median 297 MET-mins/week) and household (567.5 MET-mins/week), were the highest contributors to total PA. Low levels of occupational AOR 2.02, (CI: 1.33–3.05); transport AOR 1.49, (CI: 1.01– 2.21); and household PA 1.96, (CI: 1.33–2.91), were associated with metabolic syndrome AOR but not leisure time PA (AOR 1.18 [CI: 0.80-1.73]).	Increasing EE in domains of occupation, transport, and household PA, should be encouraged for health benefits with Malaysians.
Chu and Moy [89]	A survey that used IPAQ- Malay version, long form. MET-mins/week – standardised scoring was calculated for MPA, VPA and total PA. Sitting time = (weekday sitting x 5) + (weekend sitting x 2) + time sitting in motor vehicle. Relationship between sitting quartiles (<6 hrs/day, 6-7.59 hrs/day, 7.6-9.29 hrs/day) and metabolic risk factors with PA as reference were estimated using logistic regression.	Higher sitting time >6 hrs/day and physical inactivity were associated with metabolic syndrome. Sitting (includes occupational) ≥9.3 hrs/day was found to be linked to a 3.8-fold increase in risk. Those who completed only primary level education sat less (7.2±2.5 hrs/day) compared to those who completed a higher level of education (7.6±2.4 hrs/day). No significance differences were found relative to occupational status.	Higher occupational sitting time and insufficient PA resulted in increased metabolic risk among Malay men and women. Further, overall EE need to be encouraged to reduce sitting along with PA interventions.

AOR – Adjusted Odds Ratio

Table 6. Continued

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Padrao et al., [103]	Community-based cross-sectional study, assessing PA with GPAQ. PA level = low/moderate/high, PA intensity = moderate/vigorous. PA domains = work, transport, and recreation for 10mins continuously. SB was measured by sitting time on a typical day Associations between socio-demographic characteristics and PA (Poisson regression models).	More than three quarter or urban and rural participants (79% and 92% of men, 83% and 93% of women) achieved high levels of PA Work PA was the main contributor to overall PA, median 3hrs (urban women) and 4hrs (rural men and women), followed by transport PA of 60 mins in both rural and urban settings. Median sitting time was 2hrs in rural and urban participants. Levels of work PA (≤249 mins/day), was lower in urban and highly educated (≥6 years) participants.	Most participants in Mozambique were active, however urban dwellers and the highly educated were the most sedentary and need to improve work PA.
Bauman et al., [9]	IPAQ short form. Duration of sitting time in various life domains was categorised into quintiles. Levels of sitting in different countries were also compared. PA categories = high, moderate and low active. Time spent in vigorous, moderate and walking was equated to MET- mins for these categories. Generalised estimating equations 3, calculated the associations between highest sitting time and correlates within each country.	Total sitting time of median ≥5 hrs/day (IQR: 180 – 480 mins) was reported in 12 countries. Developed countries reported highest sitting times (≥360 mins/day), and developing countries reported lowest sitting time (≤180 mins/day). Linear Inverse relationships were found with low active group with twice high sitting time ≥540 mins/day compared with those not sitting or ≤175mins/day. Further, decreasing high levels of PA, and increasing sitting times with high active category declining across sitting (p<0.0001). Participants with more than 13 years of education (professional workers) reported a significantly (OR 1.349. 1.122,1.622), p>0.001) higher sitting time of 540 mins/day as compared to those with fewer years of education; this was common across 15 countries.	Modernisation and mechanisation has led to increases in sitting time across the world. Standing was recommended to reduce sitting, amongst highly educated individuals.

STEPwise – WHO Stepwise Approach to Survillance of Non-Communicable Disease Risk Factors

Table 6. Continued

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Bauman et al., [112]	Data from multiple surveys (using face to face interview and STEPwise Survey) from countries, were collectively used. PA = a standard protocol derived from each country defined high leisure-time PA, high work-related PA and high commuting-related PA. Associations between PA levels and sociodemographic factors (multiple logistic regression).	Low occupational PA was prevalent among men and women in China (67%,52%), Fiji (42%,14%), Malaysia (34%, 18%), Nauru (19%, 14%) and Philippines (35%, 18%). Educated adults from urban areas of Malaysia, China and Fiji (men: 17%, 18%, 39% and women: 12%, 13%, 25%), were more highly active during LPA than at work (men: 0.6%, 2%, 29% and women: 0.8%, 0.8%, 13%)	Economic and social transitions in these countries, affected PA levels.
Pronk et al., [108]	Survey with a structured questionnaire (unvalidated) and interview, measuring PA and non-occupational PA among women. Occupational PA = sitting time with reference to working hours, low = <20%, medium = 20-80%, high = >80% . EE refers to low = <8kJ/min, medium = 8-12kj/min, high = >12 kJ/min. Associations between risk of breast cancer and PA (Hazard regression).	High life time (≥25 years) occupational sitting time of ≥4 hrs/day and low occupational EE >4.64 (kJ/min) found to be risk for breast cancer. Lower risk of cancer was observed among lowest quartile of average occupational sitting time of <1.20 hrs/day, HR 0.81, (CI: 0.65,1.01) and highest quartile of average occupational EE ≥10.00 kJ/min, HR 0.73, (CI: 0.53, 0.99) and p≤0.05. Borderline significance (P-trend=<0.0001) with decreasing risk of cancer on higher levels of occupational PA.	Chinese workers with active jobs were at lower risk of breast cancer.
Rombaldi et al., [104]	IPAQ long version. Occupational PA and leisure-time PA (LTPA) = walking + moderate PA+(VPAx2) in MET-mins/week. House work PA refers to similar scoring method except walking. Insufficient PA = <150 mins/week. Associations of PA domains with sociodemographic variables (Spearman coefficient, adjusted and unadjusted).	Participants were insufficiently active in domains of LTPA (70%), occupational (58%), housework (35%), and transport-related (52%) PA. Significant correlations were observed with transport-related PA, and occupational PA (r = 0.18, P<0.001), and the house work index (r = 0.18, P<0.001).	PA promotion for Brazilians, should focus not only on the domains of LTPA but in other domains particularly in transport-related PA.

PAL - Physical activity level, PEI - Physical exertion index

Table 6. Continued

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Florindo et al., [106]	A health survey, which used IPAQ long form. MET-mins/week calculated for the past 7 days. MPA, VPA, and walking were calculated by the duration in mins/hr spent in a day x number of days/week, and total PA = walking + MPA/VPA x 7 days of at least 600 MET-mins/week, sitting = duration/ mins/hr during week day. Insufficient PA = <150 mins/week Relationship between PA levels and educational level (multivariate regression model).	Overall 7% of participants were insufficiently active, where higher prevalence was associated with transportation (92%), household (57%), occupational (69%) and leisure (57%). Higher educational level was associated with insufficient PA in occupation (76%), and household (76%) settings, but sufficient PA during leisure time (65%, p<.001).	High prevalence of insufficiently active individuals needs an attention, to promote leisure and transportation PA with Brazilians.
Gregory et al., [109]	A self-developed unvalidated PA questionnaire administered by field workers as part of a larger survey. Occupation MET = <2.3 light intensity, ≥2.3 as moderate/vigorous, MET was calculated with multiplying duration of each activity with its intensities. EE was quantified with MET*h/d and the time spent in activities (moderate/vigorous) was calculated by ≥60 min/d.	EE was high amongst all participants (median men: 37.5 MET*h/d and women: 35.2 MET*h/d. Occupation was a major contributory factor of EE (19 – 24 MET*h/d), and light intensity occupations were most common.	EE was low across all groups of occupations. Henceforth, public health campaigns should be aimed to promote PA levels and reduce sedentary time amongst men in Guatemala.
Monda et al., [90]	EE and time spent on occupational PA, was measured using interview, and a team of trained health workers measured anthropometrics and overweight status. Total occupation EE categorised on 40-h work week, MET of <3 (light = <120 MET-h/week), 3-6 (moderate = 120-240 MET-h/week), ≥ 6 (vigorous ≥ 240 MET-h/week) Relationship of occupational and domestic PA activity to body weight longitudinal linear random models).	Mean occupational and domestic EE declined over 9-year period (1991-2000). Sedentary occupations increased from 22% to 32%. Statically significance was observed with increasing occupational intensity with moderate (120 to <240 MET hrs/week, p<0.05), and vigorous occupations (240≥ MET hrs/week) resulting in lower body weight.	Urbanisation in China and transition to sedentary work has increased in China, resulting in decreases in EE and increases in weight.

Table 6. Continued

Authors	Measures and Data Analyses	Study Outcomes	Conclusions
Zhang et al., [110]	A PA survey, used questionnaire which was derived from a standardised structured questionnaire based on Hawaii Cancer Research Survey and also from Australian Health Survey. Sitting at work, low = <2 hrs/day, moderate = 2-6 hrs/day, high = >6 hrs/day. Sedentary was classified as low = <2 hrs/day, moderate = 2-4 hrs/day and high = >4 hr/day. Cut-off for total sitting time were Associations of sedentary time (<4, 4-10, and >10 hrs/day) adjusted for socio-demographic variables with risk factors of ovarian cancer (multivariate logistic regression models).	About 51% of participants with ovarian cancer and 38% without ovarian cancer spent PA of <110 MET hrs/week. Prolonged sitting at work (>6h/day), and total sitting time (AOR 1.77, CI: 1.0-3.1), were associated with higher risk of ovarian cancer, independent of BMI and PA.	Health promotion strategies that target reductions in SB at work, and total SB need tp be developed to reduce cancer risk in Chinese women.
Yamauchi et al., [111]	Heart rate monitoring, with EE estimated with indirect calorimetry. Basic metabolic rate and EE was estimated at lying, sitting and standing. TEE = Σ (sleep EE) + Σ (sedentary EE) + Σ (active EE) PAL = TEE/BMR, PEI = mean HR/ flex HR x 100, PEI >100 = active, PEI ≤ 100 = sedentary.	Mean PEI was significantly higher amongst rural agricultural occupations (gardening [p<0.001 for both sexes], gathering [males, p<0.001] and [females, p<0.05], and pig husbandry [males p<0.005] and [females p<0.05], and lower in urban cash earning occupations. Occupational PA among urban men (357±242 mins/day) was significantly higher than rural men (96±109 mins/day). However, rural women were engaged in more occupational PA (p<0.05) as compared to rural men. Reduced PAL resulted in increase in body weight (6.4kg) for both sexes.	Urbanisation contributed to a decline in EE levels amongst rural and urban migrants of Papua New Guineans.

Appendix B – STUDY ETHICS APPROVAL

THE UNIVERSITY OF QUEENSLAND

Sub-Committee Human Research Ethics Approval

Project Title:	Physical activity and sedentary behaviour amongst occupational groups in a developing country – Papua New Guinea.
Chief Investigator:	Ms Priya Karthikeyan
Supervisors:	A/Prof Nicholas Gilson, Dr. Bronwyn Clark
Co-Investigator(s):	None
School(s):	School of Human Movement and nutrition Sciences
Approval Number:	2017001343
Granting Agency/Degree:	Faculty of Health and Behavioural Sciences
Duration:	30th September 2020

Comments/Conditions:

- HREA Form, 19/09/2017
- Budget, 06/09/2017
- Study 1 - Information and Consent Form and Survey Questionnaire, 19/09/2017
- Study 2 - Information and Consent Form, 21/09/2017
- Study 3 - Information and Consent Form, 19/09/2017

Note: if this approval is for amendments to an already approved protocol for which a UQ Clinical Trials Protection/Insurance Form was originally submitted, then the researchers must directly notify the UQ Insurance Office of any changes to that Form and Participant Information Sheets & Consent Forms as a result of the amendments, before action.

Name of responsible Sub-Committee:
University of Queensland Health and Behavioural Sciences, Low & Negligible Risk Ethics Sub-Committee
This project complies with the provisions contained in the *National Statement on Ethical Conduct in Human Research* and complies with the regulations governing experimentation on humans.

Name of Ethics Sub-Committee representative:
Professor Jolanda Jetten
Chairperson
University of Queensland Health and Behavioural Sciences, Low & Negligible Risk Ethics Sub-Committee

Signature ____________________ Date **21/09/2017**

THE UNIVERSITY OF QUEENSLAND

Sub-Committee Human Research Ethics Approval

Project Title:	Physical activity and sedentary behaviour amongst occupational groups in a developing country – Papua New Guinea - 17/10/2017 AMENDMENT
Chief Investigator:	Ms Priya Karthikeyan
Supervisors:	A/Prof Nicholas Gilson, Dr Bronwyn Clark
Co-Investigator(s):	None
School(s):	School of Human Movement and Nutrition Sciences
Approval Number:	2017001343
Granting Agency/Degree:	Faculty of Health and Behavioural Sciences
Duration:	30th September 2020

Comments/Conditions:

Amendment 17/10/2017
- Changes to Survey Questionnaire
- Survey Questionnaire_Information and Consent Form, 17/10/2017

Note: if this approval is for amendments to an already approved protocol for which a UQ Clinical Trials Protection/Insurance Form was originally submitted, then the researchers must directly notify the UQ Insurance Office of any changes to that Form and Participant Information Sheets & Consent Forms as a result of the amendments, before action.

Name of responsible Sub-Committee:
University of Queensland Health and Behavioural Sciences, Low & Negligible Risk Ethics Sub-Committee
This project complies with the provisions contained in the *National Statement on Ethical Conduct in Human Research* and complies with the regulations governing experimentation on humans.

Name of Ethics Sub-Committee representative:
Associate Professor Guy Wallis
Chairperson
University of Queensland Health and Behavioural Sciences, Low & Negligible Risk Ethics Sub-Committee

Signature Guy Wallis Date **17/10/2017**

THE UNIVERSITY OF QUEENSLAND
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Additional Notes to Ethics Approval

1. The clearance number should be quoted on the protocol coversheet when applying to a granting agency and in any correspondence relating to ethical clearance.
2. Clearance will normally be for the duration of the project unless otherwise stated in the institutional clearance form.
3. Adverse reaction to treatment by subjects, injury, or any other incidents affecting the welfare and/or health of subjects attributable to the research should be promptly reported to the Head of School, the Occupational Health & Safety Unit, and the Ethics Committee.
4. Amendments to any part of the approved protocol (including change of Investigator/s), documents, or questionnaires attached to the clearance must be submitted to the Ethics Committee for approval.
5. Unforeseen events that might affect continued ethical acceptability of the project must be immediately reported to the Ethics Committee.
6. Discontinuation of the project before the expected date of completion must be reported to the Ethics Committee, giving reasons.
7. The Chief/Principal Investigator/s are responsible and accountable for full compliance of the protocol by all investigators.
8. The Committee reserves the right to visit the research site and view materials at any time, and to conduct a full audit of the project.
9. It is the Committee's expectation, whenever possible, that work should result in publication. The Committee would require details to be submitted for our records.
10. Staff and students are encouraged to contact either the Ethics Officer (3365 3924), or Chairperson on other issues concerning the conduct of experimentation/research (e.g., involvement of children, informed consent) prior to commencement of the project and throughout the course of the study.

Divine Word University
University Research Ethics Committee
Divine Word University, P O. Box 483, Madang, PNG
Tel: 675-422 1810 Fax: 675-422 2812 E-mail: mkoinari@dwu.ac.pg

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Meeting No.
Date: 19/10/2017

Mrs. Priya Karthikeyan
DWU
PO Box 483
Madang
Papua New Guinea

Dear Mrs. Priya Karthikeyan,

I am pleased to inform you that the University Research Ethics Committee (UREC) has given approval for your research proposal titled “Physical activity and sedentary behavior amongst occupational groups in a developing country – Papua New Guinea. “

UREC has given approval for your study and assigned UREC/10-2017.

Congratulations, you can proceed with the study.

Best Wishes,

Dr. Melanie Koinari
Chair, UREC

Appendix C – WORKPLACE ORIGIN OF STUDY SAMPLE

Organisations or Companies	Total workers	No of Participants	Consent rate (%)
Madang Provincial Administration	300	119	40
FRG Clothing Ltd.,	120	64	53
Brainbell & Co.	52	40	77
MST Supermarket	42	26	62
Ela Enterprises Limited	120	23	19
Ramu Agri-Industries Limited	25	15	60
Department of Justice	22	10	45
Niugini Electrical Co. Ltd.,	25	17	68
Post PNG	7	3	43
Water PNG	35	12	34
Telikom PNG	22	15	68
PNG Power Limited	35	10	29
Works PNG	32	15	47
Coconut Oil Production Madang Ltd	120	6	1*
Madang Butchery Supermarket	35	10	29
Heli Niugini Limited	81	6	1*
PNG Customs	12	4	1*
Internal Revenue Commission PNG	11	3	75

List of companies not surveyed

Ramu Nico Management Ltd	-	-
Andersons Foodland Ltd.,	-	-
WR Carpenter (PNG) Group of Companies: Globe Cannery	-	-

Decimals are rounded for percentage *

Appendix D – SURVEY QUESTIONNAIRE

Occupational and Non-Occupational Physical Activity and Sedentary Behaviour Questionnaire

(Please take part in the survey if you are more than 18 years)

Demographic Information

This section asks about the general information

1. Are you? *(Please tick one)*
   ☐ Male ☐ Female
2. How old are you? *(Please tick one)*

   ☐ 18 – 25 years ☐ 41 – 60 years
   ☐ 26 – 40 years ☐ 60 years and above
3. What is the highest qualification you have ever COMPLETED? *(Please tick one)*

   ☐ No formal education
   ☐ Primary school only
   ☐ High School
   ☐ Secondary School
   ☐ Technical or trade certificate
   ☐ Diploma or advanced diploma
   ☐ University degree
   ☐ Graduate diploma or graduate certificate
   ☐ Postgraduate degree

4. Do you work? *(Please tick one)*

   ☐ Full time ☐ Part time ☐ Casual

5. Name of your organisation____

6. What nationality are you? Or In which country were you born?

   ☐ Papua New Guinea ☐ other _________________________________

7. Height ____________________ Weight __________________________

HEALTH BEHAVIOURS

This section asks about the lifestyle behaviours that influence your health.

The following questions are about what you eat? **(NUTRITION)**

1. How many serves of vegetables (including fresh, dried, frozen and tinned vegetables) do you usually eat each day? *(Please tick one)*

1 serve of vegetables is a cup of salad, half a cup of cooked vegetables or a medium-sized potato (excluding chips)

☐ None	☐ 3 serves
☐ Less than 1 serve	☐ 4 serves
☐ 1 serve	☐ 5 serves
☐ 2 serves	☐ 6+ serves

2. How many serves of fruit (including fresh, dried, frozen and tinned fruit) do you usually eat each day? *(Please tick one)*
   1 serve of fruit is 1 medium-sized piece (or 2 smaller-sized pieces) of fresh fruit, 1 cup of canned or chopped fruit, half a cup of fruit juice, or 1½ tablespoon of dried fruit.

☐ None	☐ 3 serves
☐ Less than 1 serve	☐ 4 serves
☐ 1 serve	☐ 5 serves
☐ 2 serves	☐ 6+ serves

The following questions are about **<u>ALCOHOL</u>**

3. Have you had an alcoholic drink of any kind in the last twelve months? (*Please tick one)*

   ☐ Yes ☐ No If NO, Skip to question 6 ➡

4. On a day that you have an alcoholic drink, how many standard drinks do you usually have? *(Please tick one)*

   Refer the *show card for examples of standard drinks*. Note that a can of pre-mix spirits is 1.5 standard drinks.

   ☐ 1 or 2 ☐ 3 or 4 ☐ 5 or more

5. In the last 12 months, how often do you have more than 4 drinks on one occasion? *(Please tick one)*

☐ Never	☐ Weekly	
☐ Less than monthly	☐ Daily or almost daily	☐ Monthly

The following questions are about **SMOKING**

6. Which of the following is applicable to you: *(Please tick one)*

☐ You have never smoked cigarettes, cigars, pipes or other tobacco products
Please proceed to the International Physical Activity Questionnaire 67 section.
☐ You are an ex-smoker (Please Proceed to question 10)
☐ You currently smoke cigarettes, cigars, pipes or other tobacco products

7. Do you smoke regularly, that is, at least once a day? *(Please tick one)*

☐ Yes ☐ No If NO, Skip to IPAQ section ➡

8. If you smoke daily, on average how many cigarettes do you smoke each day?

____

9. If you smoke, but not daily, on average, how many cigarettes do you smoke per week?

____

10. In the last 12 months, have you successfully given up smoking for more than a month? *(Please tick one)*

☐ Yes ☐ No

11. In the last 12 months, have you tried to give up smoking but been unsuccessful? *(Please tick one)*

☐ Yes ☐ No

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?
   (Could you kindly tell me how many days were you doing some tough work like lifting, digging or any other activities for at least for 10 minutes at a time that make you to breath hard enough that you can't say more than a few words without pausing for breath.)

   _____ days per week ☐ No vigorous physical activities

   Skip to question 3 →

2. How much time did you usually spend doing vigorous physical activities on one of those days?

   _____ hours per day ☐ Don't know/Not sure

   _____ minutes per day

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
   (Could you kindly tell me how many days you were doing some moderate activities like carrying bags, playing tennis or other games, or any other activities not walking for at least for 10 minutes at a time that make you to breath harder than normal)

   _____ days per week ☐ No moderate physical activities

   Skip to question 5 →

4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day ☐ Don't know/Not sure

_____ minutes per day

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.
(Could you kindly tell me how many days you were doing some walking at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise or leisure or any other activities for at least for 10 minutes)

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week ☐ No walking

6. How much time did you usually spend walking on one of those days?

_____ hours per day ☐ Don't know/Not sure

_____ minutes per day

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

_____ hours per day ☐ Don't know/Not sure

_____ minutes per day

Occupational Sitting and Physical Activity Questionnaire (OSPAQ)

1. Could you kindly tell me how many hours did you worked over the last 7 days starting with yesterday? Yesterday was (e.g. Monday) did you work Monday? If so how many hours?
   Then go through the last seven days asking if they worked and how many hours they worked

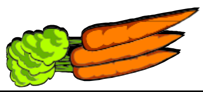
Day/date	Monday _/_/_/_	Tuesday _/_/_/_	Wednesday _/_/_/_	Thursday _/_/_/_	Friday _/_/_/_	Saturday _/_/_/_	Sunday _/_/_/_
Hours and mins worked							

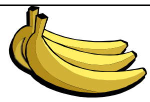
2. How would you describe your typical work day in the last 7 days? (This involves only your work day, and does not include travel to and from work, or what you did in your leisure time)
   (could you describe in percentage, the amount of time you spent last week in sitting, standing, walking, heavy labour or any physically demanding during your work time only. Kindly refer the show card for an example).

Sitting	%
standing	%
walking	%
heavy labour or physically demanding tasks	%
total	100%

This is the end of the questionnaire, thank you for participating.

NUTRITION SERVING - Typical Fruit and Vegetables and Serving Sizes

VEGETABLES are considered to be:	1 Serving =	Examples
Raw green leafy vegetables	1 cup	Spinach, salad, etc.
Other vegetables, cooked or chopped raw	½ cup	Tomatoes, carrots, pumpkin, corn, Chinese cabbage, fresh beans, onion, etc.  
Vegetable juice	½ cup	

FRUIT Is considered to be:	1 Serving =	Examples
Apple, banana, orange	1 medium size piece	 
Chopped, cooked, canned fruit	½ cup	
Fruit juice	½ cup	Juice from fruit, not artificially flavoured

Serving size One standard serving = 80 grams (translated into different units of cups depending on type of vegetable and standard cup measures available in the country).

ALCOHOL SERVING

Hours & Minutes

Minutes	Hours
60	1
120	2
180	3
240	4
300	5
360	6
420	7
480	8
540	9
600	10
660	11
720	12

Example: OCCUPATIONAL SITTING AND PHYSICAL ACTIVITY