Physical Inactivity Health Costs of Spatial Variations of Cycling in Melbourne

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Abstract

The purpose of this study was to determine if there was a spatial variation in the amount of cycling undertaken in Melbourne, Australia, and what the health and cost implications might be of such a variation. Survey data collected by Bicycle Network was used and analysed on a postcode by postcode basis for those who lived within 10km and beyond 10km of the centre of Melbourne. The results showed that the average amount of time cycling for those who cycled in the past week was almost exactly the same at approximately 5 hours for those within and beyond 10km of the centre. However, the number of people who cycled within 10km was much greater. The per capita rate of cycling was calculated and compared for the two areas with people within the 10km being nearly four times as likely to cycle as those beyond 10km. The annual health costs of physical inactivity are discussed with the potential for cycling to meet the recommended levels of physical activity. From this, it was estimated that if the rate of cycling beyond 10km in Melbourne was equal to that within 10km it is estimated this would save $550 million per annum in prevented health costs due to meeting and exceeding physical activity guidelines. However, if the spatial variation of cycling continues is likely to may lead to a spatial variation in physical activity with increased health costs for those beyond 10km and reduced costs for those within 10km.

Highlights

- Spatial analysis of cycling levels in Melbourne is established.
- Average hours for people who cycled in the past per week is the same for all parts of Melbourne.
- Per capita, people in the inner 10km nearly 4 times as likely to cycle compared to beyond 10km.
- Health costs saved would be $550 million per annum if the per capita rate of cycling were consistent across the city.

Keywords

Cycling levels, spatial variation, health costs

1. Introduction

The objective of this study is to examine the spatial variations of cycling in Melbourne and the potential health consequences of this. In the literature, physical activity has been acknowledged as a significant factor in preserving good health. The amount of time spent undertaking physical activity by individuals has been a research emphasis for several decades. This research has found low amounts of activity is a significant risk factor for numerous health conditions, including cardiovascular disease, diabetes and osteoporosis, as well as being a strong contributor to levels of obesity. In recognition of this, National Physical Activity Guidelines have been developed for all Australians including children and young people.

According to the Australian Health Survey (AHS) (ABS, 2013), a significant proportion of Australians do not get engage in enough physical activity to promote their own physical and mental well-being. According to the AHS, the level of physical activity varies spatially which is consistent with survey data from Bicycle Network (BN) regarding cycling levels. However, the BN data shows that for each person who has cycled in the last 7 days, on average they cycle the same numbers of hours wherever they are located, but simply more people cycle in the inner 10kms both per capita and absolutely than compared with beyond.

2. Material and Method

The data for this study was provided by Bicycle Network in Victoria, Australia. They conducted a survey in 2012 of members and friends assessing the level of cycling each member and friend undertook per year, per month and per week. If the survey participant undertook cycling in the past week, they were then asked how many hours they cycled. Any additional people in the household who cycled were also included in the survey. The survey included over 8000 responses which included the respondents' age, gender and post code. This data was then organised into those respondents who lived in a postcode within 10km of the centre of Melbourne, and those who lived beyond 10km. This data was then collated and analysed to determine the number or cyclists and the average number of hours each person cycled if they lived within 10km of the centre and beyond 10km. This data was then compared with the national cycling participation survey and the national guidelines on physical activity.

3. Theory and Background

3.1. How much physical activity do Australians get?

The Australian Health Survey in 2011-2012 gathered information regarding the level of physical activity Australians of all ages undertake. Children and young people undertake more physical activity than adults. The AHS found toddlers and pre-school age children (2-4 years old) had on average roughly 6 hours of physical activity, whereas 5-17 year olds undertook approximately one and a half hours. Children and young people were found to take just over 9000 steps on average per day and children aged 5–8 and 9–11 years were the two groups most likely to achieve 12,000 steps per day (22% and 24% respectively), while 15–17 year olds were least likely to (7%) (ABS, 2013).

According to the AHS, the average Australian adult undertook slightly more than 30 minutes of physical activity per day. However, when this is compared with the National Physical Activity Guidelines for adults "to do at least 30 minutes of moderate intensity physical activity on most days", only 43% of adults actually met the "sufficiently active" threshold (DoH, 2014a, ABS, 2013). In addition, how the physical activity was distributed among the adult population was highly skewed with 60% of adults engaging in less than 30 minutes per day, and less than 20% undertaking an hour or more physical activity per day. This contrasts with the amount of time engaged in sedentary leisure, with adults undertaking slightly more than 4 hours per day and nearly 30% of adults stating they engage in more than 5 hours of sedentary leisure activity every day. Of the adult population, physical activity was highest in the 18-24 year old age group. This cohort had 53% reporting an adequate amount of physical activity. The general trend was found to be that the amount of time engaging in physical activity declined according to increasing age. The age groups with the lowest amount of physical activity being people aged 75 years and over who were found on average time to spend 20 minutes per day undertaking physical activity. Only 25% of this age group were found to be sufficiently active with respect to physical activity according to the guidelines (ABS, 2013).

3.1.1. Variation in Levels of Physical Activity

People living in areas of greatest disadvantage were less likely to be sufficiently active (34%) compared with those living in areas of least disadvantage (52%). In addition the people in areas of greatest disadvantage engaged in 30% less daily activity (26 minutes) compared to the least disadvantaged group (38 minutes). This pattern was also observed when equivalised household incomes and educational attainment were compared. These results were based on the 2011 Socio-Economic Indexes For Areas (SEIFA) scores, the Index of Relative Socio-Economic Disadvantage. A

lower Index of Disadvantage quintile (e.g. the first quintile) indicates an area with relatively greater disadvantage and a lack of advantage in general. A higher score for the Index of Disadvantage (e.g. the fifth quintile) indicates an area with a relative lack of disadvantage and greater advantage in general (ABS, 2013). However, while the AHS identified these trends it did not report spatial differences in physical activity. The survey does not examine how these results may vary from one region to another or from one part of a city to another (ABS, 2013).

3.2. Physical Activity Guidelines in Australia

The Federal Department of Health issued recommendations for levels of physical activity that vary according to age. These recommendations suggest 0-5 year olds engage in three or more hours of physical activity every day and may be continuous or in several blocks throughout the day. For the 5-12 and 13-17 year old age groups, the recommendations suggest they should engage in at least one hour of moderate to vigorous physical activity every day to obtain health benefits. The health benefits are most likely to be achieved if the physical activity includes a range of aerobic activities that incorporate some activity of a vigorous intensity. The recommendations also suggest strengthening activities three days a week to develop muscle and bone. These levels are considered to be a minimum with additional health benefits obtained by being active up to several hours per day (DoH, 2014a).

For adults in the 18-65 age bracket, National Physical Activity Guidelines for Australian adults recommend at least 30 minutes of moderate intensity physical activity on most, if not all, days. To interpret the results in the AHS, this recommendation was translated in the following way which was considered to be consistent with good health:

- 150 minutes of physical activity over five or more sessions per week, classified in the survey as 'sufficiently active for health'.
- Be active on most, preferably all, days every week.
- Accumulate 150 to 300 minutes of moderate intensity physical activity or 75 to 150 minutes of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week.
- Do muscle strengthening activities on at least 2 days each week (ABS, 2013).

3.3. Physical Activity Categorisation

The AHS classified activity in the following way: walking for transport, walking for fitness and moderate and vigorous physical activity for fitness, recreation or sport, undertaken in the week prior

to interview. For sedentary behaviour, data was collected on sitting at work, sitting for transport and sitting or lying down for other social or leisure activities (ABS, 2013).

3.3.1. Type

As described above, the AHS did not categorise the type of exercise that people engaged in. Consequently, the AHS can only report on walking as a type of physical activity. Other surveys have endeavoured to identify the amounts time engaged in different activities such as cycling through the National Cycling Participation Survey conducted by Australian Bicycle Council (ABC, 2015).

3.3.2. Intensity

As specified in the guidelines, it is preferable that some vigorous activity be undertaken, however, in a practical sense, walking does not fit this category and hence does not satisfy this requirement. Other forms of physical activity such as running or cycling can be vigorous exercise.

3.4. Health Implications of Low Physical Activity

Good overall health is dependent upon many factors; however, an increasing body of evidence suggests physical activity is a very important aspect attaining and keeping good health. The amount of time spent on physical activity has long been a focus for research and policy makers with the health impacts of sedentary lifestyles rapidly gaining more evidence. The health impacts include:

- Heart, strokes and vascular disease
- Hypertension
- High blood cholesterol
- Type 2 Diabetes
- Arthritis
- Cancer
- Mental Health (ABS, 2013)

Each year in Australia, more than 16,000 people die of complications related to physical inactivity, with many more at risk from preventable diseases such as Type-2 diabetes, cancer and heart disease (Table 1).

Age	Male	Female
15 - 24	4	2
25 - 64	1,651	936
65 - 74	1,589	958
75+	4,599	6,439
Total	7,843	8,335

Table 1: Number of Deaths Due to Physical Inactivity in 2008 (KPMG- Econtech, 2008 p7).

3.5. Costs of Physical Inactivity

A study undertaken by KPMG-Econtech for Medibank Private reported that the health cost of inactivity in Australia had been estimated at $13.8 billion ($14.7 billion in 2015 dollars) per year being comprised of health care costs, productivity costs and mortality costs (KPMG- Econtech, 2008).

3.5.1. Healthcare costs

KPMG- Econtech (2008) found medical costs increased due to the direct correlation between decreased physical activity and an increased number of medical conditions. One of the main costs is the direct healthcare costs from treating the symptoms of these medical conditions. These healthcare costs are distributed between governments (public health care), private health insurance companies and through individuals who pay for treatment through their own finances. It is important to consider physical activity can be associated with some costs such as sports injuries and charges from gym membership. However, when these are taken into consideration KPMG- Econtech (2008) found direct net healthcare costs of physical inactivity to be $719 million every year in Australia.

3.5.2. Productivity Costs

The level of physical activity has also been established to affect a person's productivity. This has flow on effects for organisations as well as individuals. Lower levels of physical activity are related to increased absenteeism as well as presenteesim. Presenteesim is considered to be the phenomenon where employees present themselves to work but due to illness or other conditions are not as productive as they usually are. Hence presenteeism results in decreased productivity and as such is a cost due as the value of labour input is lower than otherwise (Deloitte, 2015). KPMG-Econtech estimated the costs of decreased labour productivity to be 1.8 working days per worker per year for an average Australian worker. This represents a cost of approximately $458 for every employee per year. Consequently, they found that in 2007/08, physical inactivity caused GDP to be around $9.3 billion ($11.39 billion in 2015 dollars) lower than would otherwise be the case (KPMG- Econtech, 2008).

3.5.3. Mortality Costs

Extensive studies in the literature have shown physical inactivity can lead to medical disorders that lead to can reduce life expectancy. The mortality cost of low levels of physical activity is often ignored; however, it is a significant factor when analysing the social and financial costs of low levels of physical activity. The impact of lowered life expectancy has both economic and social effects.

3.5.3.1. Economic cost of reduced life expectancy

Reduced life expectancy results in a smaller labour force, which can lead to a lowered output for the overall economy. KPMG- Econtech (2008) found that low levels of physical activity cost Australia $3.8 billion in 2007/08 in lost future output ($4.65 billion in 2015 dollars).

3.5.3.2. Social cost of reduced life expectancy and reduced quality of life

Reduced life expectancy through decreased physical activity also has a social cost to society. This cost is unquantifiable, as the value of life is a subjective value judgement. The social cost mainly constitutes the emotional trauma suffered by family and friends from the loss of their loved one and the reduction in happiness and mental health due to an early death.

There are also 'quality of life' costs that result from a lack of physical activity. These costs concern both the ill person and their family from a reduction in quality of life due to pain and discomfort, incapacity and distres (KPMG- Econtech, 2008).

3.6. Influences on Physical Activity

The degree to which a person engages in physical activity is affected by certain elements which include their profession and level of education, whether they are in a relationship, their gender and cultural background as well as where they live (AMA, 2014). For example, many culturally specific activities influence the level of physical activity and therefore relevant physical activity options should be available for different groups if they are to increase their amount of physical activity (AMA, 2014).

A significant issue is facilitating people with a disability to engage in physical activity. This can often require special apparatus or infrastructure. Infrastructure, or the built environment, is also an issue for people without a disability. There is compelling evidence that different urban planning and civil engineering approaches produce drastically different physical activity outcomes (Carlson et al., 2014, Mayne et al., 2015). Aspects of the built environment that are a factor in the level of physical activity

include access to walking paths, cycle paths, parks and recreation facilities as well as well-connected streets (Townshend et al., 2015).

3.7. Physical Activity Alternatives

Options for increasing physical activity generally focus on increasing the amount of walking and joining exercise groups or gyms (DoH, 2014b). A much neglected option in Australia has been to increase physical activity through cycling in general and commuting in particular (Holland, 2011). This is an area of great potential and deserves greater levels of study. To determine the potential for increasing physical activity through cycling, it is necessary to measure the current levels of cycling. This has been explored through the National Cycling Participation Survey (NCPS) commissioned by the Australian Bicycle Council (ABC, 2015).

3.8. Cycling Activity Levels in Australia

The National Cycling Participation Survey asked whether the respondent had cycled in the past year, month or 7 days. These results are show in Figure 1.

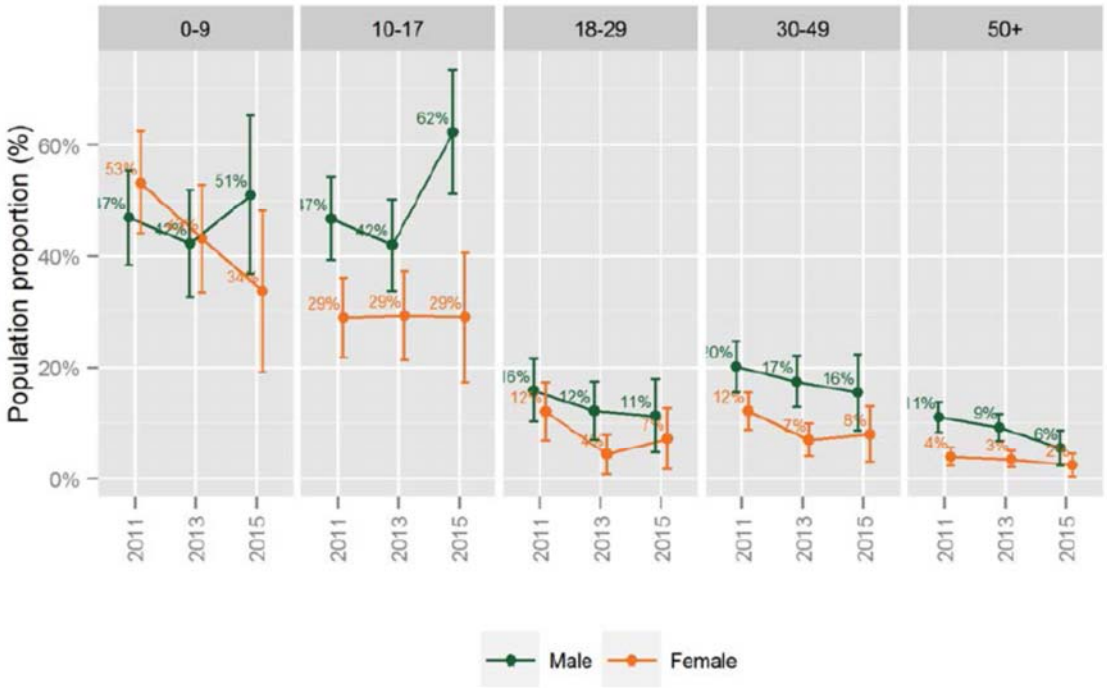

Figure 1: Cycling participation by age and gender (ABC, 2015 p6)

Those who cycled in the previous 7 days were asked to estimate how many hours they cycled in those previous 7 days. The average figure for all respondents was 2.75 hours per week. As Figure 1

shows, the percentage of people who cycled in the previous 7 days was approximately 17% for all ages. Of the adult population, 9.5% cycled in the previous 7 days. The age and gender split is shown in Figure 2.

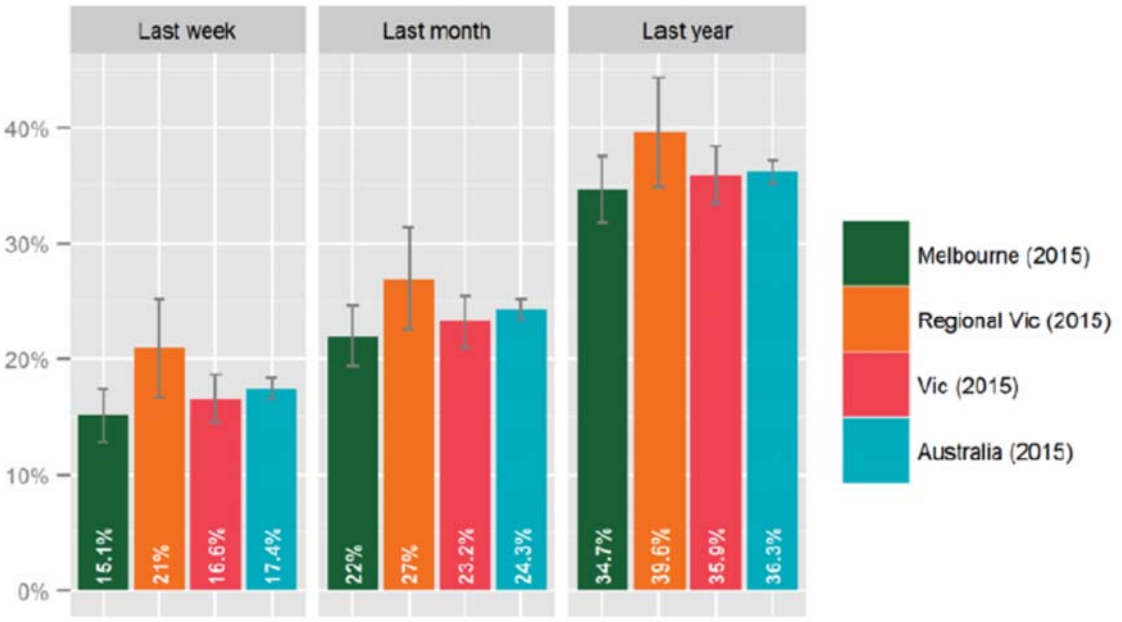

Figure 2: Cycling participation in the last week, month and year (ABC, 2015 p4)

3.9. Can Cycling add to Physical Activity Levels and Associated Benefits?

Numerous studies have documented the many health benefits generated by cycling in terms of reduced risk for cardiovascular diseases, stroke, cancer, and type 2 diabetes, and consequently mortality (e.g. Börjesson and Eliasson, 2012, Deenihan and Caulfield, 2014, Sahlqvist et al., 2012). A meta- analysis of the extant literature on the health benefits of cycling was undertaken by both Oja et al. (2011) and the World Health Organization WHO (2014). Both studies found a strong inverse relationship between all-cause mortality and cycling as a form of physical activity.

Börjesson and Eliasson (2012b) suggested that an increase in the number of cyclists may not lead to an increase in health benefits, because cycling is a substitute for other forms of exercise. However, this is highly contested as active travel is widely promoted as a way for sedentary people to incorporate exercise into their daily life (White et al., 2014), as well as contrary findings by Sahlqvist et al. (2012). Cycling is time-efficient, particularly in areas of high traffic congestion, and is competitive compared with some forms of public transport such as buses and trams, which frequently stop to pick up and set down passengers. Thus cycling is the most competitive mode of

journey for distances of up to 5 kilometres in terms of time spent in travelling (Ellison and Greaves, 2011). However, short distances are irrelevant if there are barriers to conducting a journey by cycling — for example, traffic, weather and road conditions, or obstacles such as highways, rivers or railways with no safe and convenient crossing.

Cycling also has the potential to encourage moderate and vigorous intensity exercise, an option not available to walking. As the Australian Health Guidelines state, some physical activity each week should be moderate or vigorous in intensity. Vigorous intensity physical activity generally provides increased health benefits (AMA, 2014). However, the AMA emphasise that it is important to recognise that some of the largest gains in health and wellbeing are made by people who shift from being physical inactive (sedentary) to moderate amounts of physical activity as shown in Figure 3. This suggests sedentary people who use a bicycle for short trips (up to 5km) may derive the most benefit, as they would previously have travelled in a private motor vehicle.

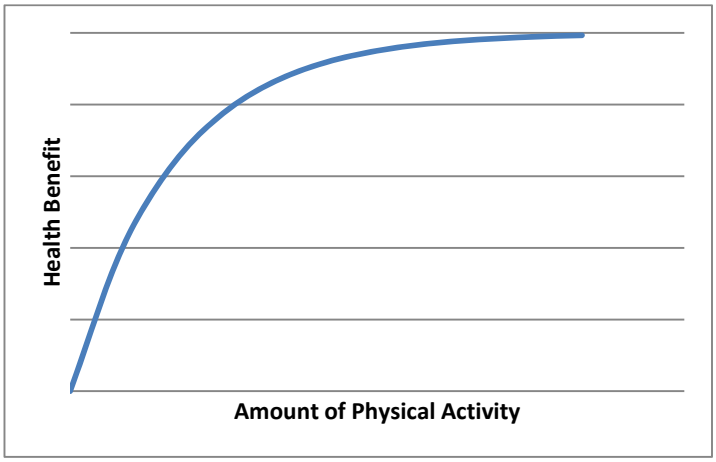

Figure 3: Marginal Benefit of Physical Activity (adapted from Wen et al., 2011 p1249)

4. Results

4.1. Spatial Variation of Cycling in Melbourne

The NCPS results are not spatially mapped, therefore the variation of cycling levels across space is not clear. Bicycle Network (BN) has undertaken surveys of members and friends (former members or people wishing to keep in contact with BN), which includes postcodes of the respondents. These surveys are similar in structure to the NCPS and gather information on cycling in the past year, month and previous 7 days. As with the NCPS, if respondents had cycled in the previous 7 days, they were then asked how many hours they had cycled in that time. From this data, it is possible to build

up an idea of how cycling varies across Melbourne on a postcode basis. Anecdotal evidence suggests cycling is much more prevalent in inner Melbourne than in the outer areas, which have implications for levels of physical activity across different areas of Melbourne. The BN data is consistent with the anecdotal evidence

The BN data was divided into postcodes that are within 10km of the centre, and those beyond 10km. The results of the hours cycled for members and friends in the previous 7 days have been summarised in Table 2 and Table 3. The results show remarkable similarities in the average amount of hours each cyclist undertakes whether they are in the inner 10km or beyond and whether they are members or friends with all cycling approximately 5 hours in the previous 7 days. This is nearly twice as much as the average figure reported figure in the NCPS. This suggests BN members and friends are more likely to ride more hours than the general populace (Bicycle Network, 2012). This is not a surprising result.

This level of activity is twice as much as the recommended weekly amount of physical activity for adults. Therefore, on average, the respondents to BN's survey gained all their recommended physical activity and more through cycling, much of which is on the journey to work.

The major difference is found between the inner 10kms and beyond is the number of cyclists and more specifically the number of cyclists who have cycled in the last 7 days per postcode. Postcodes in the inner 10km have approximately 4 times as many cyclists on average compared with postcodes beyond 10km, when this is converted to a per capita basis; people in the inner 10kms are 3.7 times more likely to cycle in the previous 7 days than those beyond 10km of the city. However, if they cycle, they will on average cycle the same amount of hours.

Members					
Area	Total hours cycled	Total number of cyclists	Average hours per cyclist	Average hours per postcode	Average cyclists per postcode
Inner 10km	16935.5	3218	5.3	260.5	49.5
Beyond 10km	14049	2627	5.3	66.9	12.5

Table 2: BN Members' hours cycled in past 7 days (Bicycle Network, 2012)

Friends					
Area	Total hours cycled	Total number of cyclists	Average hours per cyclist	Average hours per postcode	Average cyclists per postcode
Inner 10km	13571	2713	5.0	208.8	41.7
Beyond 10km	9480.5	1947	4.9	45.1	9.3

Table 3: BN Friends' hours cycled in past 7 days (Bicycle Network, 2012)

These survey results lend support to the anecdotal evidence that cycling is primarily an inner city phenomenon in Melbourne, but what are the physical activity and health implications of cycling being primarily an inner city phenomenon?

Overall, according to the NCPS (ABC, 2015), 15.1% of people in Melbourne cycled in the last 7 days. 15.1% of the population of Melbourne in 2015 of approximately 4.4 million means 664,400 people in Melbourne cycled in the past 7 days. Assuming the ratio of people cycling in the inner 10km and beyond from the BN data of 3.7:1 applies to all cyclists, then the spatial split can be calculated. As the population of Melbourne in the inner 10km is approximately 1 million, and the population beyond 10km is 3.4 million, this equates to 346,000 people cycling in the inner 10km and 318,000 people beyond 10km (Figure 4). This means approximately 35% of people in the inner 10kms cycled in the previous 7 days, as opposed to 9% beyond 10km (Figure 5).

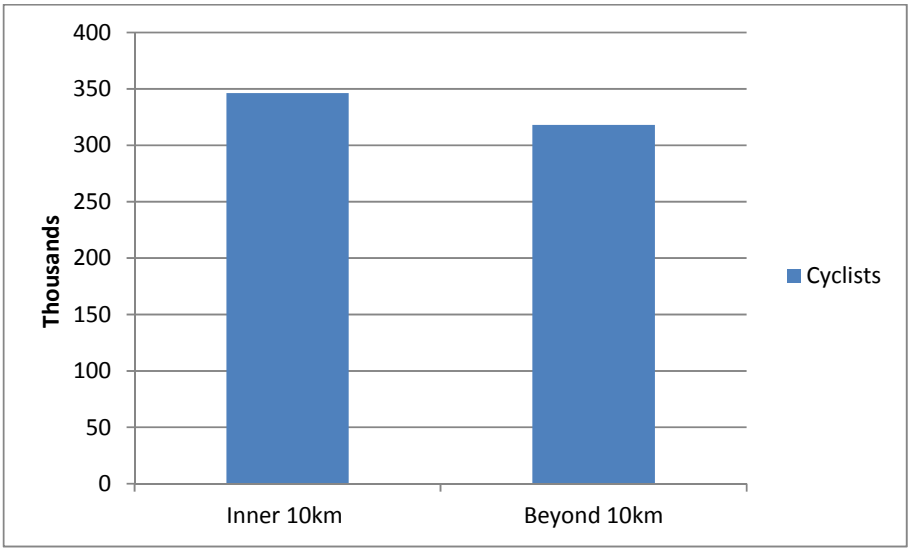

Figure 4: Spatial Distribution of People who have Cycled in the Previous 7 days in Melbourne: Absolute Number (Bicycle Network, 2012)

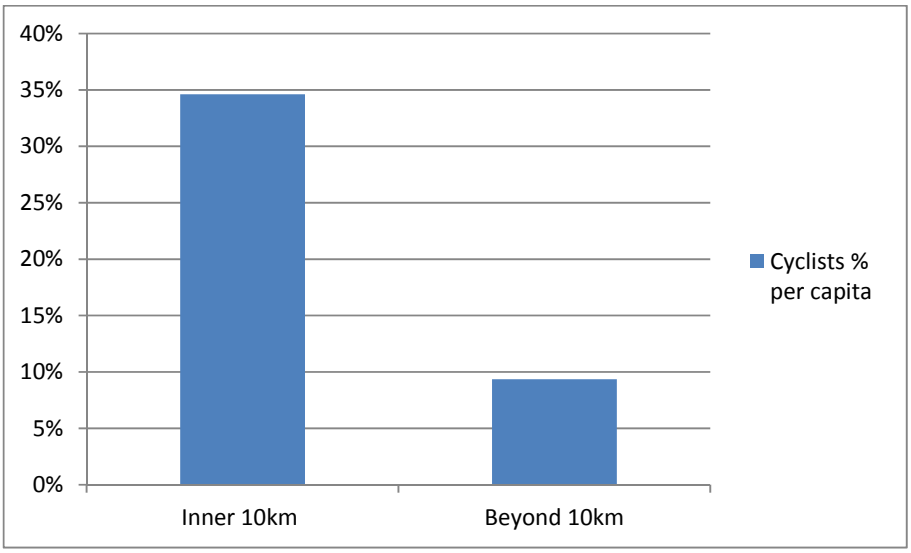

Figure 5: Spatial Distribution of People who have Cycled in the Previous 7 days in Melbourne: % per capita (Bicycle Network, 2012)

5. Discussion

5.1. Health costs and implications of spatial variation of cycling in Melbourne

The consequences of the spatial variation of cycling in Melbourne are clear: the populace in the areas beyond 10km are less likely to achieve the recommended level of physical activity through cycling, and ceteris paribus, they are less likely to achieve their recommended levels of physical activity. This suggests that people living in suburbs beyond 10km are more likely to experience health issues associated with inactivity including heart disease, type 2 diabetes, arthritis, cancer and mental health issues.

This also suggests people in the inner 10km are more likely to reach their recommended levels of physical activity, especially if the average amount cycled was 165 minutes for those who cycled in the previous 7 days. If the number of cyclists per capita in the area beyond 10km were to equal that in the inner 10km, an additional 860,000 people would meet their recommended levels of physical activity. The health benefits and financial savings of an additional 860,000 people cycling would be substantial. If the annual cost of physical activity of $14.7 billion per annum (2015 dollars) is divided by the population of 23 million, this represents a figure of $639 per person. If the rate of cycling participation in the area of Melbourne beyond 10km increased to match the inner 10km by people who were previously sedentary, this would save $550 million per annum in prevented health costs in Melbourne alone.

However, should the current arrangement continue, with declining levels of cycling in the areas beyond 10km, then the chance of people reaching the level of recommended physical activity will decrease and the health costs will increase. The converse is true for the areas within 10km with a high proportion already reaching their recommended physical activity levels through cycling. This suggests there are long-term implications from one generation to the next of not meeting the physical activity in the outer areas of Melbourne, while those close to the city will have better health forming a health hot spot in the centre.

If these results are replicated in Sydney, Brisbane, Perth and Adelaide, this has significant implications for physical activity and health and wealth of Australia, as the majority of the population in these cities reside beyond the 10km radius.

5.2. Further Research

Further research is needed to establish the reasons why such a spatial variation exist with an obvious hypothesis being the relative lack of high quality bicycle infrastructure in the areas of Melbourne beyond 10km. A potential study may examine the amount of bicycle infrastructure as well as the Level of Service of that infrastructure with cycling levels. Additional theories point to cultural differences in the inhabitants in the different parts of Melbourne with some suggesting bicycle usage correlates with the level of voters who vote for the Australian Greens political party (Davies, 2013).

Further study of the financial benefits of more people cycling in the area beyond 10km in Melbourne has the potential to change health and transport priorities with potential environmental benefits as well.

6. Conclusion

There is no doubt that physical activity is vitally important to physical and mental health and that Australians are not getting enough physical activity. This issue is of such importance the Federal Department of Health issues guidelines for the general populace, and the lack has an enormous financial cost to society. In 2012, the Department of Infrastructure and Transport estimated the cost of physical inactivity to be $13.8 billion per year which comprised healthcare, productivity and mortality costs. The Australian Health Survey does not measure the levels of cycling, rather it surveys the amount of walking, moderate and vigorous activity, however, the National Cycling Participation Survey (NCPS) and the Bicycle Network member surveys give some insight into the amount of cycling and hence physical activity undertaken by Australians. According to the NCPS, those who have cycled in the previous 7 days in Melbourne (15.1%) did so for an average 165 minutes in that time.

However, BN members and friends cycled approximately 300 minutes per week. These results show that those who choose to cycle get their recommended amounts of physical activity through cycling alone and the BN members and friends over twice the recommended amount. However, the BN survey results show that the number of people cycling is approximately 3.7 times greater on a per capita basis in the inner 10km than in the postcodes beyond 10km. This means the populace in the areas beyond 10km are less likely to achieve the recommended level of physical activity through cycling and ceteris paribus less likely to achieve their recommended levels of physical activity. The consequences of this suggest that people living in postcodes beyond 10km are more likely to experience health problems associated with inactivity including heart disease, type 2 diabetes, arthritis, cancer and mental health issues. Given the majority of Australians live in the outer suburbs of Australia cities, cycling has the potential to address the level of physical activity by increasing the number people cycling to the levels in the inner 10km, which in Melbourne would mean an additional 860,000 people. This is especially the case as the marginal health benefits are greatest for those transitioning from being sedentary to moderate amounts of exercise.

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