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Exercising choice: The economic determinants of physical activity behaviour of an employed population

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Abstract

Lack of physical activity is a major contributing factor to the worldwide obesity epidemic, and to the overall burden of disease. The deindustrialisation of developed economies and move to more sedentary employment has impacted on the opportunities of working individuals to participate in physical activity. This can have negative effects on productivity and worker health potentially influencing economic growth. Thus, it is important to determine the factors influencing the frequency of participation in physical activity for employed individuals. This paper uses a modified time allocation framework to explore this issue. We use data from the first six waves of the Household Income and Labour Dynamics of Australia survey (HILDA). The analysis examines frequency of participation in physical activity using a generalised random effects ordered probit model. We control for non-parallel cut-points between the physical activity categories and individual heterogeneity, as well as exploring differences across gender. The results indicate that there is a time trade-off between non-market work, market work, and the frequency of physical activity participation. This effect is moderated by gender. For example, dependent children have a larger negative effect on the frequency of physical activity participation for women. Education and marriage have a larger negative effect on the frequency of participation for men. The findings suggests that policies which make exercise more convenient, and hence decrease the opportunity cost of exercise, will help to encourage more frequent participation in physical activity for working adults.

Keywords

Australia; Physical activity; Time allocation; Health; Built environment; Employment

Introduction

Approximately 1.9 million deaths worldwide are attributable to physical inactivity (World Health Organisation – WHO, 2009). In Australia, where the data in this paper comes from, physical inactivity was the fourth leading cause of burden of disease in 2003, responsible for approximately 7% of the total burden of disease (Begg et al., 2007). At least 30 min of moderate physical activity[1] five days a week reduces the risk of coronary heart disease, stroke, type II diabetes, and, specifically for women, the risk of colon and breast cancer

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[1]Moderate physical activity is defined as an activity that uses large muscle groups and is at least equivalent to brisk walking. Some examples are dancing, cycling, gardening, and swimming (CDC, 1996).

(Center for Disease Control (CDC), 1996; WHO, 2009). A lack of physical activity has also been found to have a negative effect on worker productivity. Workers who are physically inactive have higher rates of absenteeism than physically active workers. This affect is magnified in workers in sedentary occupations (van den Heuvel et al., 2005 and van Amelsvoort, Spigt, Swaen, & Kant, 2006). Evidence from Australia suggests that around 70% of adults are participating in less physical activity than this recommended amount, and that almost 50% of adults reported none or virtually no exercise in the past two weeks (Australian Bureau of Statistics, 2006).

It has been found that efforts to promote participation in physical activity are more effective if they address the needs of a particular target group (Booth, Bauman, Owen, & Gore, 1997). For this reason we focus on employed individuals who are more likely to be cash rich and time poor. A better understanding of how economic and demographic factors influence the frequency of physical activity participation for working individuals can help policy makers and firms to design better tools to increase participation, reducing the disease burden and increasing productivity. To determine which factors influence physical activity participation a modified time allocation framework based upon the seminal work of Becker (1965) and the Cawley (2004) 'SLOTH' framework[2] is applied to an unbalanced panel of individuals aged 18–65 from the first six waves of the Household Income and Labour Dynamics of Australia (HILDA) survey (2001–2006). The physical activity variable is an ordinal measure of physical activity on a six point scale ranging from no reported activity to participation in physical activity on a daily basis.

Individuals have a finite amount of time to devote to market work, non-market work and leisure, which includes both sedentary activities and more active pursuits. There are time and cost inputs associated with these activities. The basic assumption is that as the opportunity cost of physical activity increases due to work or home commitments, individuals are less likely to exercise. The analysis controls for manual workers who will have a different opportunity cost of physical activity than employees in more sedentary employment.

Evidence suggests that time constraints are a significant barrier to physical activity participation for women (Verhoef & Love, 1994; Welch, McNaughton, Hunter, Hume, & Crawford, 2008). Working mothers who juggle employment and motherhood may perceive that they do not have the time to participate in physical activity, negatively impacting on their health and productivity. Thus, it is important to separately analyse the determinants of physical activity participation for working men and women who may face different time constraints impacting on the opportunity cost of physical activity participation.

A small number of papers have considered the economic determinants of physical activity participation. Farrell and Shields (2002) examine the influence of the family, income, and ethnicity utilising a binary variable for sporting participation and data from the Health Survey of England. The binary variable is equal to one if the respondent participated in an episode of physical activity that lasted for at least 15 min over the last four weeks and is zero otherwise. Eberth and Smith (2010) use the Scottish Health Survey to investigate the relationship between participation and duration after controlling for a number of economic and demographic factors. Humphreys and Ruseski (2007, 2009), use data from the US Behavioural Risk Factor Surveillance System to look at the decision to participate and the amount of time allocated to physical activity, and also the effects of state level spending on parks and recreation. Downward (2007) explores the economic choice to participate in sport using the UK General Household Survey. The general findings from these studies are that

[2]SLOTH stands for Sleep, Leisure, Occupation, Transportation and Home Based Activities (Cawley, 2004).

people with children, married people, employed people and women do less exercise, while those with higher incomes do more.

Our study makes a number of important contributions to the literature. Firstly, we focus on workers who have an easily identifiable opportunity cost of time measured by the observed wage rate. We can use this information to investigate how time and budget constraints influence the frequency of physical activity participation and if this differs by gender. Time pressures associated with employment may increase the time and cost burden of non-market related activities for employed individuals especially women. This may change the magnitude and the significance of the demographic and economic factors included in previous studies that focused on the general adult population. This has important policy implications for effective tools to increase participation for this important sub-group. Secondly, given that the variable we use to measure participation in physical activity is an ordinal one, we employ a generalised random effects ordered probit framework. This allows us to test the parallel regression assumption of the standard ordered probit model by permitting the shift into different physical activity categories to vary by individual characteristics. This aspect of potential heterogeneity in frequency has not been explored in previous work. Thirdly, unlike the existing studies, we have a physical activity question based upon weekly, rather than monthly, participation thus reducing recall bias.

Theoretical framework

The theoretical framework is based on the model described in Humphreys and Ruseski (2009). The basic idea is that given time and budget constraints, individuals choose how to allocate their time between leisure (including physical activity), market work, and non-market work, in order to maximise a given utility function comprising consumption of commodities and leisure. In equilibrium the marginal value of household production, the marginal rate of substitution between consumption and leisure activities (including physical activity) and the market wage rate are equal. Due to data limitations regarding types of physical activity in the data source, it is assumed that the physical activity encapsulated in both non-market and market work is fixed. Thus, our focus is on how the amount of discretionary/leisure time available influences the frequency of physical activity participation.

Physical activity participation requires inputs of both time and market goods. Assuming an individual chooses the amount of time they work, then the wage rate will determine how much time individuals devote to market work, non-market work, and leisure. This will influence the opportunity cost of participating in physical activity. The more time constraints faced by an individual the less likely they will devote time to frequent physical activity participation. It is expected that working men and women may have different time constraints as traditionally women tend to be the primary caregiver for dependent children. This suggests that time pressures may affect the optimal frequency of weekly physical activity participation differently for men and women. The time allocation framework suggests there may be a role for supporting and promoting workplace physical activity programs that reduce the opportunity cost of participating in frequent physical activity.

Econometric framework

Physical activity (P_{it}) is a an ordinal variable of participation measured on a six point scale ranging from no activity to daily activity for individual i in period t. Participation in each physical activity category is influenced by how individuals divide their time between market, non-market work, and leisure, represented by a vector of individual characteristics (X_{it}) including age, sex, marital status, and income; geographical area variables (R_{it}) for example, urban and rural identifiers such that:

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$$
\begin{aligned}
P(P_{it} = 0|\alpha_i) &= F(-X_{it}B_0 - R_{it}\psi_0 - \alpha_i) \\
P(P_{it} = m|\alpha_i) &= F(-X_{it}B_m - R_{it}\psi_m - \alpha_i) \\
&-F(-X_{it}B_{m-1} - R_{it}\psi_{m-1} - \alpha_i) \\
&\vdots \\
P(P_{it} = M|\alpha_i) &= 1 - F(-X_{it}B_{m-1} - R_{it}\psi_{m-1} - \alpha_i)
\end{aligned} \quad (1)
$$

Where m=1,…5 and M=6 (the categories in the dependent variable, P_{it}).

The model is estimated using a random generalised ordered probit (REGOP). This framework allows for non-parallel cut-points. The REGOP model estimates a set of coefficients for each of the $M-1$ points at which the dependent variable can be dichotomised; this includes the constant term. The effects of the explanatory variables in Equation (1) can vary with the point at which the categories of the dependent variable are dichotomised. The standard normal distribution function that employs $F(.)$ as the cumulative distribution is used to estimate the model. It is assumed that the individual effects are normally distributed with a zero mean and variance σ^2. If this assumption does not hold then the results will be biased and inconsistent.

One solution would be to remove the individual effects using a fixed effect model. However, there are many computational problems when estimating a fixed effects generalised ordered probit. The one dimensional parameters have to be re-estimated as a potentially limitless number of $(n+K)-n$ parameters. Therefore, to estimate the parameters of the model it will be necessary to compute the possibly huge number of constant terms at the same time. This presents a practical obstacle to the estimation of the model as there is a need to invert a potentially large second derivative matrix (Greene, 2003). For this reason, a fixed effect approach is not applied.

We test the normality of the individual effects in two ways. Firstly, the residuals from the individual effects are plotted on a graph. This method shows the residuals for all six physical activity categories to be normally distributed. Secondly, the predicted residuals from the individual effects are compared to the predicted residuals where normality is imposed on the predicted residuals. The numbers should be similar if the residuals are normally distributed. This appears to be the case. For example the mean predicted residuals for participating in physical activity three times a week is 0.293, with normality imposed the mean of predicted residuals are 0.297. Both methods show the residuals to be normally distributed suggesting our results should be consistent.

The random effects estimation framework assumes the independence of the unobserved effects (α_i) and the explanatory variables contained in vectors X and R in Equation (1). If this assumption is violated the resulting coefficient estimates are inconsistent. To address this problem we use the Mundlak (1978) method. This methodology takes the group means of the time explanatory variables to remove the time invariant individual effects from the model allowing for unbiased estimation.

The model is estimated using the user-written command *regoprob* in STATA v.11 (Boes, 2006).

We assume in the theoretical framework that economic and demographic factors will influence the frequency of physical activity participation differently for men and women. This informs our decision to estimate Equation (1) separately for men and women. To test this hypothesis we implement a Chow-type test. A dummy variable for being female is created. This dummy variable is then multiplied by the explanatory variables in vectors X and R. We then estimate the model for the whole sub-sample of employed individuals:

$$\begin{aligned} &P(P_{it} = m|\alpha_i) = F(-X_{it}B_m - R_{it}\psi_m - W_{it}\xi_m - W_{it}(X_{it}B_m) - W_{it}(R_{it}\psi_m)\alpha_i) \\ &-F(-X_{it}B_{m-1} - R_{it}\psi_{m-1} - W_{it}\xi_{m-1} - W_{it}(X_{it}B_m) - W_{it}(R_{it}\psi_m)\alpha_i) \\ &\vdots \\ &P(P_{it} = M|\alpha_i) = F(-X_{it}B_{M-1} - R_{it}\psi_{M-1} - W_{it}\xi_{M-1} - W_{it}(X_{it}B_{M-1}) - W_{it}(R_{it}\psi_{M-1}) - \alpha_i) \end{aligned} \quad (2)$$

This differs from Equation (1) because of the inclusion of a dummy variable for being female which is represented by W_{it}. The female indicator variable is interacted with the vectors, X_{it} and R_{it}. A Wald test is then performed to determine whether the dummy variable for female and the female interaction terms are statistically significant. The null-hypothesis is that the three variables are not significant. The null-hypothesis is rejected for all three variables suggesting that separate estimation by working men and women is warranted.

A problem, common to longitudinal datasets like HILDA, is sample attrition. If individuals sharing similar characteristics such as poor health exit the survey this may bias the results. Table 1 shows the movement in and out of the HILDA for the employed sub-sample used in the analysis. Item non-response to the physical activity and employment status question are controlled for in the table. For both men and women the highest rate of raw attrition occurs moving from wave 1 to wave 2, 14.9% for men and 12.2% for women. The rate declines over time with a raw attrition rate of 4.5% for men and 2.4% for women between waves and 5 and 6. By wave 6, the original sample of 9464 men is 7979 and the original 9897 women have declined to 8648.

A Verbeek and Nijman (1992) test is performed to determine whether sample non-response will bias the results. This test constructs variables that reflect the pattern of non-response from each survey respondent. A binary variable that equals one if the respondent was present in the last wave and zero otherwise, a continuous variable for the number of waves the respondent is present, and an indicator variable that equals one if the respondent is present in all waves and zero otherwise are added separately to Equation (1). The equation is then estimated three times with each of these three variables. The statistical significance of the added variables provides a test for attrition. The null-hypothesis is that the three variables are not significant. This test has little power as it cannot correct for attrition. In all three models for both employed men and women the null-hypothesis of random non-response cannot be rejected in any case, thus we do not expect that attrition will bias our results.

Data and variables

The HILDA is a nationwide household panel survey with a focus on issues relating to families, income, employment, and well-being. It was designed to be consistent with the British Household Panel Survey (BHPS) and the German Socio-Economic Panel (GSOEP). Survey methodology and the motivation behind the creation of the HILDA are described in greater detail in Watson and Wooden (2006). The first wave was conducted between August and December 2001, the sample is extended each year to include any new household members. We use the first six waves of the survey (2001–2006). An unbalanced panel is used. The analysis is restricted to working individuals in the 18–65 age range; respondents working outside this age range may possess characteristics that are different to the typical worker biasing our findings. The sample is comprised of 6767 men and 6379 women.

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Physical activity

The physical activity measure is a categorical variable constructed from the question:

> "In general how often do you participate in moderate or intense physical activity for at least 30 min? Moderate physical activity will cause a slight increase in breathing and heart rate such as brisk walking."

The response choices are: 1)*Not at all;* 2) *less than once a week;* 3) *1–2 times a week;* 4) *3 times a week;* 5) *more than three times a week but not everyday;* 6) *everyday*.

Fig. 1 shows the distribution of physical activity participation by gender. A higher percentage of women compared to men never participate in physical activity or participate less than once a week. A higher percentage of men compared to women participate in the more frequent physical activity categories of more than three times a week and everyday.

Similar to other physical activity measures from secondary datasets there are weaknesses associated with the physical activity measure. The question does not specify the type or duration of physical activity. Thus, we cannot determine whether different types of physical activity affect the frequency of participation differently. We are also unable to analyse the relationship between frequency and duration of activity. The self-reported nature of the physical activity measure means that it may be subject to measurement error. Controlling for individual heterogeneity should remove some of this bias. To compare the HILDA with other Australian surveys, a binary variable that equals one if the respondent participates in the recommended amount of physical activity (3 or more times a week) and zero otherwise was constructed for the whole HILDA sample. In the whole HILDA sample, 52.7% of men and 46.5% of women participate in physical activity three or more times a week. This is comparable to other national and regionally representative samples. For example, in the New South Wales Population Survey 2002–2005, 52.6%of men and 43.8% of women report participation in moderate or vigorous activity, three days a week or more, for at least 30 min, over the past seven days (Chau et al., 2008).

Covariates

The explanatory variables included in this analysis are used to explore how time allocation influences the frequency of physical activity participation. Age and age squared are included in the model. It is possible that the relationship between age and physical activity participation is concave thus we allow for a non-linear relationship between age and frequency of participation in physical activity. Education is controlled for in the models because higher levels of education may increase the potential wage rate. If physical activity is a normal good, individuals with more education may substitute active leisure for paid work, *ceteris paribus*. However, individual preferences and knowledge about the health benefits of physical activity may suggest a positive association between physical activity participation and education. An indicator variable for marital status is included in all equations. Married individuals may have more time commitments, such as family obligations, which increases the amount of time allocated to non-market work compared with single respondents. Farrell and Shields (2002) and Humphreys and Ruseski (2009) found a negative effect of being married on physical activity and sporting participation for both genders. Three indicator variables for having dependent children four and under, children between the ages of five and fifteen, and fifteen and older are included in the models. The age of dependent children will influence how much leisure time is available which will effect physical activity participation. For example, Farrell and Shields (2002) find that having dependent infants reduces the likelihood of sporting participation for both men and women. Non-labour income is expected to increase participation in physical

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activity and this is supported by findings from the previous literature (Farrell & Shields, 2002 and Humphreys & Ruseski, 2009).

To capture how individual preferences influence participation in physical activity a time satisfaction variable is included in the model. Welch et al. (2008) found, amongst a sample of 1521 Australian women, that 73% reported time pressures as a barrier to physical activity participation. While actual total time available to an individual is fixed at 24 h per day, perception of time available can vary, and perception of the amount of available leisure time may impact on physical activity participation. If individuals devote what they perceive as a large proportion of their total time to market and non-market work, resulting in dissatisfaction with the amount of leisure time available, they may be less likely to devote part of this leisure time to physical activity. Thus we expect a negative effect from the variable that identifies people who are dissatisfied with the amount of leisure time they have. The time satisfaction variable may be correlated with some of the other explanatory variables such as age of dependent children possibly affecting the interpretation of the regression results. Multicollinearity between the potentially correlated explanatory variables is checked by calculating a Pearson correlation coefficient between time satisfaction and each of the three dummy variables for dependent children. The correlation coefficient for time satisfaction and children was approximately 0.13 for women and 0.09 and insignificant for men suggesting multicollinearity should not be a serious problem.

The built environment may influence both the time and cost of participating in physical activity. There is some evidence that the built environment may act as a barrier to participating in physical activity if individuals do not have local access to parks, cycling and walking paths, and other sports facilities (Committee on Physical Activity, Health, Transportation and Land Use, 2005). The character of the neighbourhood may influence the likelihood of participating in outdoor physical activity. Saelens, Sallis, Black, and Chen (2003) found that neighbourhoods with high crime rates, boarded up shop fronts, and poorly maintained infrastructure discouraged walking and cycling. Two built environment variables are included in the analysis. The first variable controls for living in an urban environment and the other variable controls for the socio-economic disadvantage of the local area.

Labour market variables such as number of hours worked, and the wage rate, will affect the position of the budget constraint. We assume that working full-time will increase the opportunity cost of participating in physical activity. Nomaguchi and Bianchi (2004) find that full-time workers participate in less physical activity than their part-time counterparts. van den Heuvel et al., 2005 and van Amelsvoort et al. (2006) find evidence of increased productivity of physically active employees. Physical activity has also been found to improve emotional well-being (WHO, 2009). Therefore, participating in regular physical activity may have productivity effects which could lead to a higher wage rate, resulting in an upward bias on the coefficients on the wage variable. However, if physical activity is a normal good, then a higher wage rate will cause individuals to substitute physical activity for paid work. Empirically, it may be possible that these two effects cancel each other. Another factor impacting on physical activity for employed respondents is the type of industry in which they are employed. The physical activity question in the HILDA does not explicitly distinguish between leisure and work based physical activity. Individuals employed in manual labour will participate in more work-related physical activity which may lead them to report that they are physically active, even though this activity is in work time rather than leisure time. Thus, the model controls for employment in a more physically active job.

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Results

Table 2 shows the descriptive statistics for the sample used in the empirical analysis. Except for employment status all descriptive statistics are only for the employed sub-sample used in the analysis. The statistics are divided by frequency of participation in physical activity, and shown separately for men and women. The first category is defined as no weekly physical activity participation. The second category of less than once a week suggests that most weeks these respondents do not participate in physical activity; their participation is infrequent. The remaining three categories of one to two times a week, three times a week, between 4 and 6 times a week, and everyday show the frequency of physical activity participation for those respondents who choose to participate in exercise on a regular basis. After controlling for participation, differences can be observed in the distribution of the frequency of physical activity participation. For many of the economic and demographic variables there seems to be a glut of respondents reporting participating in one to two days of physical activity. For most of the variables there are a higher percentage of men than women reporting participation in physical activity everyday. For example only 6% of working mother with children under the age of four report participating in physical activity everyday compared with 14% of working fathers with children in this age group. This suggests time constraints may affect the frequency of physical activity participation differently for working men and women.

Table 3 presents the marginal probability effects for employed men and women from the REGOP model. The coefficients show how marginal changes in the explanatory variables impact on the frequency of participation. For the dummy variables included in the analysis this change is moving from the base category to a positive response (a value of one). The base category in the dependent variable is never participating in moderate physical activity. The coefficients can be interpreted as percentages.

The REGOP framework allows the shift to be non-parallel between physical activity categories for all explanatory variables. This assumption is tested for each explanatory variable individually and the full model using a Wald χ^2 test. The null-hypothesis is that the parallel line assumption is violated. The bottom row in Table 3, column (1) for men and column (6) for women shows the χ^2 test-statistics for the full model, the *p*-values are shown in columns (2) for men and (7) for women. The null-hypothesis cannot be rejected for either men or women suggesting the REGOP is an appropriate model specification compared with an ordered probit model with parallel cut-point shifts. The Wald χ^2 for the individual variables is not shown. The null-hypothesis is rejected for school age children ($p = 0.77$) and children fifteen plus ($p = 0.49$) for men. For women, the null-hypothesis is rejected for the second education dummy (Certificate I, II, III, IV) ($p = 0.81$) and the urban indicator variable ($p = 0.68$). The null-hypothesis of non-parallel cut-points between the physical activity categories holds for the other explanatory variables.

For ease in explaining the effect of the explanatory variables on the frequency of physical activity participation, we will explain how the marginal probability changes across columns (1–5) for men and (6–10) for women for each explanatory variable. The percent changes will be compared between men and women.

The magnitude of the marginal effects on non-labour income, hourly wage, and age squared are extremely small for both men and women and for ease of exposition are rounded to zero in Table 3.For example, for men in column (1) the marginal effect of non-labour income on participating in physical activity less than once a week is −0.00002 and in column (5) for men the marginal effect for participating in physical activity everyday compared to the base category of no physical activity is 0.00002. The magnitude of the marginal effects on non-labour income is similar for women in columns 6–10. For both genders, only in the final column, (column (5) for men and column (10) for women), participating in physical activity everyday compared to the base category of no physical activity participation is there a positive coefficient on non-labour income. The marginal effects on hourly wage for men in column (1) is 0.0004, the marginal effect switches signs to negative in column (3), (−0.00007) and is negative in columns (4) and (5). The marginal effect on hourly wage for women in column (6) is 0.00002 and the sign of the marginal effect changes to negative in column (10) only, (−0.0002). The small magnitude of the non-labour income and hourly wage marginal effects suggests that monetary subsidies to promote physical activity participation may only lead to less than a 1% change in more frequent physical activity participation compared to the base category of no physical activity participation.

Full-time employment compared to part-time employment has a positive effect on participating in daily physical activity for men in column (5). This contradicts our time allocation framework. However, men may choose to work part-time because of health reasons which could explain these counterintuitive findings. Full-time employment compared to part-time employment has a negative and significant effect on more frequent physical activity participation for women which can be seen in columns (7), (9), and (10).

Manual work compared to the base category of non-manual occupations has a positive and significant effect on reporting more frequent physical activity participation. This suggests manual workers incorporate occupational physical activity when answering this survey question. The opportunity cost of physical activity is different for manual workers compared to employees in more sedentary occupations. Approximately 10% of men and 7% of women are employed in manual work suggesting the difference in the opportunity cost of physical activity participation for manual workers should not bias our findings on the impact of economic and demographic factors on the frequency of physical activity participation. These findings highlight a weakness of our analysis. The physical activity question in the HILDA which does explicitly ask respondents about type of physical activity limits our ability to fully identify the impact of the explanatory variables on the frequency of physical activity participation.

Compared to the base category of living in a rural area, living in an urban area has a negative and significant effect on participating in more frequent physical activity for both men and women. This negative and significant effect holds across all columns of increasing frequency of participation. Living in areas of higher deprivation compared to the base category of living in the least deprived areas has a negative effect on participating in physical activity less than once a week to participating between 4 and 6 days for men in columns (1–4) and women in columns (6–9). The magnitude of this effect is larger for men than women. These findings suggest the built environment may play a role in the frequency of physical activity participation. Or more generally the built environment may influence the likelihood of participating in physical activity. This issue should be addressed in future work.

The impact of children on the frequency of physical activity participation is gender specific. For example, having a dependent child under the age of four compared to having no children in this age group decreases the likelihood of participating in physical activity three times a week compared to the base category of no physical activity by 21% for men (column 3) and 30% for women (column 8). Older children in the five to fifteen age groups and fifteen plus compared to having no children in these age groups only have a negative and significant effect on the frequency of physical activity participation for women. This suggests that child care is a significant burden on the likelihood that women participate in more frequent physical activity. This issue needs to be addressed when developing policy to increase working women's physical activity participation.

Compared to single, widowed or divorced respondents, marriage has a negative and significant impact for more frequent physical activity participation for men. This can be seen in columns (3–5). This is consistent with our theoretical framework that the additional non-market work associated with marriage increases the opportunity cost of participating in more frequent physical activity. Compared to the base category of no physical activity participation, marriage only has a negative and significant effect on participating in physical activity one to two days a week (column 7) and three times a week (column 8) for women. Child care rather than other non-market work associated with marriage may be a larger burden on time influencing the time allocated to physical activity for women.

The base category for the education dummies are no educational qualifications. We will focus on the result for respondents with a bachelor degree or higher. Interestingly a tertiary degree has a positive and significant effect on lower levels of physical activity participation compared to the base category of no physical activity participation. See columns (1–2) for men and columns (6–8) for women. The effect is larger for men than women. However, the sign of the coefficient changes when moving into more frequent participation categories. Males with tertiary degree are 30% less likely to participate in physical activity between 4 and 6 days a week and 63% less likely to participate in physical activity everyday compared to the base category of no physical activity participation. Similarly women with tertiary degree are 25% less likely to participate in physical activity everyday. This adds support to our hypothesis that the rising opportunity cost of physical activity participation impacts on the frequency of participation. Highly educated individuals are likely to know about the health benefits of physical activity. Thus, they may choose to participate in physical activity. These individuals are more likely to have highly skilled sedentary jobs. The time commitments associated with work and other non-market commitments suggests that the opportunity cost of physical activity may limit their weekly physical activity opportunities. Workplace physical activity opportunities may benefit this group and increase the frequency of physical activity participation.

Finally, being dissatisfied with the amount of free time available compared to being satisfied has a positive effect on lower levels of frequency (columns 1–2) and a negative and significant effect on daily physical activity participation for men (column 5). This is consistent with the theoretical framework that time perception will influence the opportunity cost of physical activity. However, for women there is a positive effect of being dissatisfied with free time on the frequency of physical activity participation (columns 6–9). This is inconsistent with our hypothesis suggesting that for working women time perception may not factor into the frequency of physical activity participation.

Discussion

There are some important policy implications that can be drawn from this research. Non-labour income has an extremely small impact on the frequency of physical activity participation suggesting that subsidies for physical activity participation or other payment schemes for exercise may not be an effective policy tool to increase the frequency of participation for working adults. The negative impact of non-market responsibilities such as child care and marriage suggests there may be a trade-off between these activities and physical activity participation. These findings are similar to other research in the area studying the general population (Eberth & Smith, 2010; Humphreys & Ruseski, 2009, and Farrell & Shields, 2002)The negative impact of higher levels of education on the frequency of physical activity participation implies that there may be a time trade-off between working and physical activity. The impact of non-labour income and education differs from findings in the previous literature which focused on the general population (Eberth & Smith, 2010 and Farrell & Shields, 2002). For employed individuals time constraints may be more important than budgetary constraints on the frequency of physical activity participation.

Workplace physical activity programs may be an effective way to increase the frequency of physical activity for time poor working people. Child friendly physical activity programs may be an effective way to increase working women's physical activity participation. Such policies can also help to foster good habits in children improving their health. The results suggest that the built environment has a significant impact on the frequency of physical activity participation. Ensuring the built environment encourages physical activity participation is important for town planners, local and national governments. This area should be further investigated in future work.

There are several limitations to this study. The nature of the physical activity question limits the interpretation of our results. We cannot explicitly distinguish between leisure based and work based physical activity. Therefore, we can only provide an approximation of how time allocation influences physical activity participation. The majority of the sample is employed in more sedentary employment suggesting that our results should provide a reasonable approximation on how time allocation influences the frequency of leisure based physical activity participation. Secondly, the physical activity question does not explicitly ask respondents about duration and vigour. Therefore, we cannot determine if participation in moderate versus vigorous physical activity and duration impacts on the frequency of physical activity participation.

Conclusion

Frequent physical activity participation is important for promoting a healthy population. Understanding the economic and demographic factors which influence the frequency of physical activity participation will help policy makers target at risk groups. The role of work on the frequency of physical activity participation has not been investigated in the previous literature. This paper aimed to uncover the economic and demographic factors which influence the frequency of physical activity participation for working adults in Australia using a modified time allocation framework and a REGOP model that allows a non-parallel shift point between physical activity categories.

The findings suggest that economic and demographic factors that influence how time is allocated between non-market work, leisure, and market work have a significant impact on the frequency of physical activity participation for working men and women. Many of these factors are moderated by gender. For example, marriage has a larger negative effect on the frequency of participation for men than women. Dependent children have a larger negative effect on the frequency of physical activity participation for women compared to men.

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References

Australian Bureau of Statistics. Selected 2006 census facts and figures. 2006. Viewed May 2009. http://www.abs.gov.au

Becker GS. A theory of the allocation of time. Economic Journal. 1965; 75:493–517.

Begg, S.; Vos, T.; Barker, B.; Stevenson, C.; Stanley, L.; Lopez, AD. The burden of disease and injury in Australia, 2003. AIHW; Canberra: 2007. PHE 82

Boes, S. REGOPROB: Stata module to estimate random effects generalized ordered probit models, Statistical Software Components S456604. Boston College Department of Economics; 2006.

Booth ML, Bauman A, Owen N, Gore CJ. Physical activity preferences, preferred sources of assistance, and perceived barriers to increased activity among physically inactive Australians. Preventative Medicine. 1997; 26:131–137.

Cawley J. An economic framework for understanding physical activity and eating behaviour. American Journal of Preventive Medicine. 2004; 27:117–125. [PubMed: 15450622]

Center for Disease Control and Prevention (CDC). Physical activity and health: A report of the surgeon general. Department of Health and Human Services; Washington D.C: 1996.

Chau J, Smith BJ, Bauman A, Merom D, Eyeson-Annan M, Chey T, et al. Recent trends in physical activity in New South Wales. Is the tide of inactivity turning? Australia and New Zealand Journal of Public Health. 2008; 32:82–85.

Committee on Physical Activity, Health, Transportation, and Land Use. Does the built environment influence physical activity: Examining the evidence. Transportation Research Bureau; Washington D.C: 2005.

Downward PM. Exploring the economic choice to participate in sport: results from the 2002 general household survey. International Review of Applied Economics. 2007; 21:633–653.

Eberth B, Smith MD. Modelling the participation decision and duration of sporting activity in Scotland. Economic Modelling. 2010; 27:822–834. [PubMed: 20640033]

Farrell L, Shields MA. Investigating the economic and demographic determinants of sporting participation in England. Journal of Royal Statistical Society. 2002; 165 A:335–348.

Greene, WH. Econometric analysis. Prentice Hall; Upper Saddle River, NJ: 2003.

Humphreys BR, Ruseski JE. Participation in physical activity and government spending on parks and recreation. Contemporary Economic Policy. 2007; 25:538–552.

Humphreys, BR.; Ruseski, JE. The economics of participation and time spent in physical activity. Department of Economics, University of Alberta; 2009. Working Paper Series, Paper No. 2009–09

Mundlak Y. On the pooling of time series and cross-section data. Econometrica. 1978; 46:69–85.

Nomaguchi KM, Bianchi SM. Exercise time: gender differences in the effects of marriage, parenthood, and employment. Journal of Marriage and Family. 2004; 66:413–430.

Saelens BE, Sallis JF, Black JB, Chen D. Neighbourhood-based differences in physical activity: an environment scale evaluation. American Journal of Public Health. 2003; 93:1152–1158.

van Amelsvoort LGP, Spigt MG, Swaen GMH, Kant I. Leisure time physical activity and sickness absenteeism; a prospective study. Occupational Medicine. 2006; 56:210–212. [PubMed: 16641504]

van den Heuvel SG, Boshuizen HC, Hilderbrandt VH, Blatter BM, Ariens GA, Bongers PM. Effect of sporting activity on absenteeism in a working population. British Journal of Sports Medicine. 2005; 39 doi:10.1136/bjsm.2004.013052.

Verbeek M, Nijman T. Testing for selectivity bias in panel data models. International Economic Review. 1992; 33:681–703.

Verhoef MJ, Love EJ. Women and exercise participation: the mixed blessings of motherhood. Health Care Women International. 1994; 15:297–306.

Watson N, Wooden M. Modelling longitudinal survey response: The experience of the HILDA survey. 2006HILDA Project Discussion Paper Series

Welch N, McNaughton SA, Hunter W, Hume C, Crawford D. Is the perception of time pressure a barrier to healthy eating and physical activity among women? Public Health Nutrition. 2008; 23:1–8.

World Health Organisation (WHO). Physical activity. 2009. viewed April 2009. http://www.who.int/dietphysicalactivity/pa/en/index.html

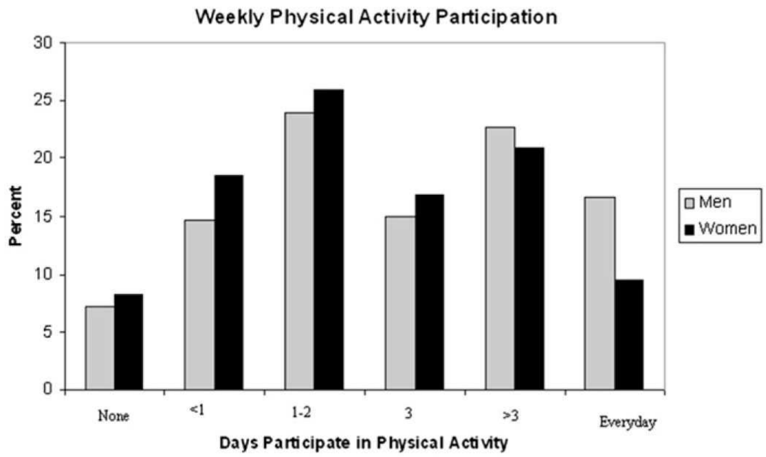

Fig. 1.
Categorical physical activity (PA) participation variable. Notes: the *x*-axis shows the number of days participated in physical activity in a typical week. More than three is between four and six days a week. Source: Waves 1 – 6 (2001–2006) of the HILDA.

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Table 1

Sample size, drop outs, rejoiners, survival rate (%) raw and net attrition rate (%).

Wave	No. indiv	Drop outs	Rejoiners	Survival rate	Raw attrition	Net attrition
Men						
1	9464	–	–	–	–	–
2	8437	141	388	89.1%	14.9%	10.9%
3	8240	588	391	87.1%	7.0%	2.3%
4	8001	604	365	84.5%	7.3%	2.9%
5	7986	383	368	84.4%	4.8%	1.8%
6	7979	358	351	84.3%	4.5%	0.01%
Women						
1	9897	–	–	–	–	–
2	8953	1204	260	90.5%	12.2%	9.5%
3	8840	371	258	89.3%	4.1%	1.3%
4	8553	561	274	86.4%	6.3%	3.2%
5	8608	215	270	87.0%	2.5%	−1.0%
6	8648	206	246	87.4%	2.4%	−0.04%

Notes: Drop outs are non-respondents at wave t and respondents and wave $t-1$. Rejoiners are respondents at wave t and non-respondents at wave $t-1$. Raw attrition rates exclude rejoiners. Net attrition rates include rejoinders. Table controls for item non-response in the physical activity and employment variables.

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Table 2 Descriptive statistics.

Physical activity	**Never**	**<1**	**1–2 time**	**3 times**	**>3 times**	**Everyday**	**n**
Men							
Employed	0.07	0.15	0.24	0.15	0.23	0.17	33106
Not in the labour force/unemployed	0.19	0.12	0.19	0.13	0.22	0.16	33106
Manual work	0.08	0.11	0.17	0.12	0.23	0.28	23271
Employed full-time	0.07	0.15	0.25	0.15	0.22	0.16	23283
Hourlywage	17.73	21.03	21.96	21.22	20.44	15.75	23252
Nonlabour income	1656.05	1289.55	1153.42	1162.99	1167.18	1530.97	23283
Age	42.39	40.28	39.19	38.85	39.76	38.99	21840
Year 12 or undefined certificate	0.06	0.13	0.25	0.16	0.24	0.16	23283
Certificate I, II, III, IV	0.08	0.15	0.23	0.14	0.22	0.18	23283
Diploma/advanced diploma	0.06	0.17	0.27	0.14	0.22	0.14	23283
BA or higher	0.05	0.15	0.28	0.18	0.22	0.09	23283
Children aged zero to four	0.08	0.18	0.28	0.14	0.18	0.14	23283
Children aged five to fifteen	0.08	0.18	0.25	0.15	0.21	0.14	23283
Children aged fifteen plus	0.09	0.16	0.24	0.14	0.22	0.15	23283
Married/cohabiting	0.07	0.16	0.25	0.14	0.22	0.15	23279
Single/divorced/widowed/separated	0.06	0.11	0.20	0.15	0.23	0.19	23279
Inner regional/outer regional/remote	0.07	0.14	0.21	0.14	0.23	0.21	23283
Major city	0.07	0.15	0.25	0.16	0.22	0.14	23283
Medium deprivation	0.07	0.15	0.24	0.14	0.23	0.17	23275
High deprivation	0.09	0.16	0.22	0.13	0.21	0.19	23275
Dissatisfied with free time	0.08	0.17	0.23	0.14	0.19	0.19	23272
Women							
Employed	0.08	0.19	0.26	0.17	0.21	0.10	39159
Not in the labour force/unemployed	0.16	0.14	0.21	0.13	0.17	0.10	39159
Manual work	0.11	0.16	0.20	0.14	0.22	0.16	21318
Employed full-time	0.08	0.19	0.25	0.16	0.21	0.09	21318
Hourlywage	18.02	18.84	18.78	18.76	19.33	17.34	21278
Nonlabour income	1775.25	1472.62	1451.64	1362.64	1289.39	1521.26	21078

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Physical activity	Never	<1	1–2 time	3 times	>3 times	Everyday	n
Age	40.98	38.62	37.74	38.36	39.53	40.98	20032
Year 12 or undefined certificate	0.09	0.21	0.27	0.17	0.18	0.08	21318
Certificate I, II, III, IV	0.10	0.19	0.24	0.15	0.20	0.11	21318
Diploma/advanced diploma	0.05	0.17	0.25	0.20	0.21	0.09	21318
BA or higher	0.06	0.18	0.27	0.18	0.22	0.08	21318
Children aged zero to four	0.09	0.22	0.30	0.16	0.17	0.06	21318
Children aged five to fifteen	0.09	0.21	0.28	0.16	0.18	0.08	21318
Children aged fifteen plus	0.10	0.19	0.25	0.16	0.20	0.10	21318
Married/cohabiting	0.09	0.19	0.26	0.16	0.21	0.09	21314
Single/divorced/widowed/separated	0.08	0.17	0.26	0.18	0.21	0.10	21314
Inner regional/outer regional/remote	0.07	0.18	0.25	0.16	0.22	0.12	21318
Major city	0.09	0.19	0.26	0.17	0.20	0.08	21318
Medium deprivation	0.08	0.19	0.26	0.17	0.21	0.11	21315
High deprivation	0.11	0.20	0.25	0.15	0.20	0.09	21315
Dissatisfied with free time	0.12	0.27	0.32	0.19	0.21	0.10	21314

Notes: With the exception of employment status, all descriptive statistics are for the employed sub-sample used in the analysis. All variables are given in percentages with the exception of age (years), hourly wage and household income (Australian dollars). n = number of observations ($i*t$).The percentages in each category for the categorical and indicator variables are calculated by taking the total n with a positive response in the categorical/indicator variable in all six physical activity categories and dividing this by the number of respondents with a positive response for the category/indicator variable in each physical activity category. For example, n = 4478 for employed women with dependent children over the age of 15. n = 439 for employed women with dependent children over the age of 15 who participate in physical activity everyday. 439/4478 = 0.08 or the percentage of women with dependent children over the age of 15 that participate in physical activity everyday.

Table 3

Random generalised ordered probit for employed men and women (marginal probability effects shown).

	Men					Women				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	<1	1–2	3	>3	Everyday	<1	1–2	3	>3	Everyday
Nonlabour income	0.00**	0.00**	0.00	0.00	0.00**	0.00*	0.00**	0.00**	0.00	0.00
Hourlywage	0.00**	0.00*	0.00	0.00*	−0.01**	0.00*	0.00	0.00	0.00	0.00
Employed full-time	−0.01	−0.04	−0.06	−0.04	0.14**	−0.03	−0.08**	−0.02	−0.10**	−0.17**
Manual work	−0.08	0.08	0.20**	0.27**	0.34**	−0.21**	−0.04	0.13**	0.27**	0.42**
Major city	−0.17**	−0.20**	−0.23**	−0.26**	−0.25**	−0.22**	−0.17**	−0.18**	−0.19**	−0.20**
Medium deprivation	−0.18**	−0.20**	−0.13**	−0.08*	0.00	−0.19**	−0.17**	−0.11**	−0.06	−0.01
High deprivation	−0.37**	−0.35**	−0.22**	−0.13**	0.03	−0.35**	−0.29**	−0.17**	−0.09*	−0.03
Children aged 0–4	−0.16**	−0.16**	−0.21**	−0.20**	−0.08	−0.25**	−0.23**	−0.30**	−0.23**	−0.20**
Children aged 5–15	0.02	−0.03	−0.01	−0.01	−0.02	0.04	−0.06	−0.18**	−0.18**	−0.15**
Children aged 15+	−0.07	−0.01	−0.04	−0.04	0.00	−0.04	−0.08*	−0.14**	−0.15**	−0.04
Married/cohabiting	0.03	−0.07	−0.17**	−0.13**	−0.12**	−0.08	−0.13**	−0.11**	−0.06	−0.09
Age	−0.04**	−0.06**	−0.05**	−0.04**	−0.05**	−0.05**	−0.02	0.01	0.01	0.01
Age squared	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00	0.00	0.00	0.00
Year 12 or undefined certificate	0.23**	0.13*	−0.02	−0.15**	−0.30**	0.13*	0.00	−0.07	−0.15**	−0.18**
Certificate I, II, III, IV	0.15**	0.10*	0.02	−0.06	−0.13**	0.03	0.05	0.02	0.02	0.07
Diploma/advanced diploma	0.40**	0.11	−0.15*	−0.26**	−0.41**	0.47**	0.31**	0.14**	−0.09	−0.22**
BA or higher	0.60**	0.30**	−0.03	−0.30**	−0.63**	0.44**	0.28**	0.11**	−0.03	−0.25**
Dissatisfied with free time	0.14**	0.16**	0.05	0.02	−0.16**	0.12**	0.20**	0.15**	0.12**	−0.01
n	21787					19994				
ρ	0.53***					0.56***				
log-likelihood	−33856.37					−30808.90				
χ^2	33.74***	(0.00)				23.08**	(0.00)			

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Notes: The base category in the model is never participating in moderate physical activity. Columns (1) for men and (6) for women then show a marginal change in the explanatory variables influencing the likelihood of participating in less than one day a week of physical activity compared to never participating in physical activity. Columns (2) for men and (7) for women show how a marginal change in the explanatory variables influence the likelihood of participating in 1–2 two days of physical activity compared to the base category of no physical activity, the same line of reasoning can be used to explain the interpretation of the marginal probabilities in columns (3–5) for men and (8–10) for women. The coefficients can be interpreted as percentages. The Wald χ^2 is for the parallel line assumption test for the full model. The *p*-value for the test is in column (2) for men and column (7) for women. The null-hypothesis is the parallel line assumption is violated.

** Indicates significance at the 1% level

* Indicates significance at the 5% level.