Test-Retest Reliability of Transport-Related Physical Activity Performed During the Lifetime

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**Background:** One of the convenient ways to achieve recommended levels of physical activity is through 'active transport,' such as walking or cycling to and from work or school. Although studies have shown that participants can reliably recall information about recent transport-related physical activity, it is not known if the reliability remains high when asking about lifetime behavior. This study tested the reliability of questions that collect information about transport-related physical activity performed over the lifetime.

**Methods:** Participants were asked to complete self-administered questions about transport-related physical activity on 2 separate occasions. The questions asked about cycling and walking to and from work and/or school during 3 age periods: 15–24 years, 25–39 years, and 40 years and above. A lifetime average was also calculated for cycling, walking, and total activity. **Results:** There was fair to good test-retest reliability of the age-period specific questions for transport-related cycling (ICCs from 0.65–0.74), walking (ICCs from 0.44–0.58), and total activity (ICCs from 0.57–0.66). The reliability of the lifetime averages were also fair to good (ICCs from 0.58–0.70). **Conclusions:** The questions tested in this study have moderate reliability, and appear to be useful questions for measuring lifetime transport-related physical activity.

**Keywords:** data collection, epidemiologic methods, measurement, reproducibility of results

Physical activity is an important risk factor for the leading noncommunicable diseases. However it is a multifaceted behavior that is challenging to measure. Physical activity can occur in different domains, such as sports and leisure activities (recreational), at work (occupational), in the home (household), and traveling to and from work or school (transport-related). In recent years researchers have begun to focus on measuring physical activity in specific domains, rather than a global measure of physical activity. One of the convenient ways to achieve recommended levels of physical activity is through 'active transport,' such as walking or cycling to and from work or school. Transport-related physical activity has been associated with a decreased risk of various chronic diseases, and people who regularly cycle or walk to work are less likely to be obese than those who do not.

For many chronic diseases, such as colon and breast cancers, there is evidence that physical activity performed in the past, or over the lifetime, may result in a greater risk reduction than more recent physical activity. There are questionnaires that have been shown to reliably measure recreational, household, and/or occupational physical activity performed in the past, and studies have shown that participants can reliably recall information about transport-related physical activity performed in the last week or a typical week. However, it is not known if people can reliably recall information about the transport-related physical activity they have performed in the past. Therefore, we conducted a study to determine the test-retest reliability of questions that collect information about transport-related physical activity performed over the lifetime.

**Methods**

This test-retest reliability study was conducted as part of the Breast Cancer Environment and Employment Study (BCEES), a case-control study of breast cancer that was conducted in Western Australia between 2009 and 2011. Participants in the BCEES were asked to complete a self-administered questionnaire containing questions about various breast cancer risk factors, including physical activity performed during 3 age periods: 15–24 years, 25–39 years, and 40 years and above. The physical activity section of the questionnaire contained items about recreational, household, and transport-related physical activity. The recreational and household questions were based on others that have been shown to be reliable, so they were not included in this reliability study. The transport-related physical activity questions asked about walking to and from work or school and cycling to and from work or school. The questions followed the same
format as those used to collect information about recreational and household activities—participants were asked to record the age first started, number of years, months per year, and hours per week that they spent performing the 2 transport-related physical activities in each age period. Participants were able to indicate that they had not performed either of the transport-related activities in the age period. The physical activity questionnaire used in the BCEES is available as Supplementary Material.

Participants who returned their BCEES questionnaire between May and September 2010 were invited to participate in the reliability study. Those who consented completed a second set of the transport-related physical activity questions, approximately 1 week after the BCEES questionnaire was returned. Ethics approval for this reliability study was received from Human Research Ethics Committees at the University of Western Australia and the Western Australian Department of Health, and informed written consent was obtained from all participants.

Analysis

For each age group, the total hours that each participant spent performing each transport-related activity was calculated. This total was then multiplied by a metabolic-equivalent (MET) value from the Compendium of MET-values, resulting in a MET-hour total for each activity.17 Cycling to and from work or school was assigned a MET value of 8.0, and walking to and from work or school was assigned a MET value of 3.3.17 This total was then divided by the number of weeks that a participant spent in the age period, resulting in a MET-hours per week value for each participant. We also combined the 2 activities and calculated the total MET-hours per week spent performing transport-related activity, and also calculated the average MET-hours per week over the lifetime for walking, cycling, and total transport-related activity.

To determine the test-retest reliability of the questionnaire we used the intraclass correlation coefficient (ICC, Type 2,1).18 A total of 12 ICCs were calculated (MET-hours per week spent performing transport-related walking, cycling, and total activity in each of the 3 age periods and over the lifetime) for all participants, as well as for cases and controls separately. As the data were not normally distributed all values were log-transformed, after addition of one to account for zero values and values less than 1.19

For total transport-related physical activity in each age period and over the lifetime we recalculated the ICCs after removing the participants who reported no transport-related on either administration of the questionnaire, and we also examined whether reliability differed between younger participants (less than 55 years of age) and older participants (aged equal to or greater than 55 years). The following cut-off points were used to interpret the ICCs: 0–0.4 = poor agreement; 0.40–0.75 = fair to good agreement; 0.75–1.0 = excellent agreement.20

For total transport-related physical activity in each age period and over the lifetime we also produced Bland-Altman plots.21 These are plots of the difference in MET-hours per week between the 2 questionnaires against the average MET-hours per week of the 2 questionnaires. Participants who reported no activity in an age period (or over the lifetime) on both questionnaires were not included in the Bland-Altman plots.

All analyses were performed using Stata 11 (Statacorp, College Station, Texas, USA).

Results

Response

A total of 405 participants were sent an information sheet and a second copy of the questions relating to transport physical activity. Of these 405 participants, 353 (87.2%) returned the second questionnaire. Complete data for both questionnaires were available from 292 (72%) participants (130 cases and 160 controls). The participants were aged between 32–80 years. The median age was 59 years. All participants were female. The median time between completion of the 2 questionnaires was 19.5 days.

Prevalence

The prevalence of transport-related physical activity was highest in the youngest age period, with over 50% of the participants reporting walking and/or cycling for transport between the ages 15–24 years (Table 1). The prevalence decreased to around 20% between 25–39 years of age, and approximately 10% after the age of 40 years. Transport-related walking was more prevalent than transport-related cycling in each of the age periods.

Test-Retest Reliability

The test-retest reliability of the age-period specific questions ranged from 0.65–0.74 for transport-related cycling, 0.44–0.58 for transport-related walking, and 0.57–0.66 for total transport-related physical activity (Table 1). The reliability of the lifetime averages for transport-related cycling, walking, and total activity ranged from 0.58–0.70 (Table 1).

Removing the participants who reported no transport-related physical activity on either administration of the questionnaire resulted in ICCs of 0.50, 0.58, 0.56, and 0.56 for total transport-related physical activity between the ages 15–24 years, 25–39 years, after the age of 40 years, and over the lifetime respectively.

The reliability coefficients were generally higher for controls than for cases, particularly for the cycling questions (Table 1). Reliability did not differ between older and younger participants for total transport-related physical activity between the ages of 15–24 years (ICCs = 0.66 for both age groups) or over the lifetime (ICCs = 0.65 and 0.69 for the younger and older age groups, respectively). Older participants were able to recall total transport-related physical activity between the ages of 25–39 years more reliably (ICCs = 0.50 and 0.66 for the younger and older age groups, respectively), while
<table>
<thead>
<tr>
<th>Age period</th>
<th>1st questionnaire</th>
<th>2nd questionnaire</th>
<th>Intraclass Correlation Coefficient (95% CI)</th>
<th></th>
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</thead>
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<tr>
<td></td>
<td>Mean MET-hours</td>
<td>% reporting</td>
<td>Mean MET-hours per week (SD)</td>
<td>% reporting</td>
</tr>
<tr>
<td></td>
<td>per week (SD)</td>
<td>any</td>
<td>per week (SD)</td>
<td>any</td>
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<td>15–24 years</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Cycling</td>
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<td>22.2</td>
<td>2.6 (8.2)</td>
<td>21.9</td>
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<tr>
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<td>3.9 (8.2)</td>
<td>44.5</td>
<td>4.5 (9.5)</td>
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<tr>
<td>Total</td>
<td>7.8 (18.3)</td>
<td>56.8</td>
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<tr>
<td>25–39 years</td>
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<td></td>
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<td></td>
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<tr>
<td>Cycling</td>
<td>0.5 (3.3)</td>
<td>4.8</td>
<td>0.6 (4.7)</td>
<td>4.1</td>
</tr>
<tr>
<td>Walking</td>
<td>0.7 (2.5)</td>
<td>14.0</td>
<td>1.5 (6.2)</td>
<td>18.2</td>
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<tr>
<td>Total</td>
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<td>17.1</td>
<td>2.1 (7.9)</td>
<td>20.5</td>
</tr>
<tr>
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<td></td>
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<tr>
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<td>2.4</td>
<td>0.8 (7.3)</td>
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<tr>
<td>Walking</td>
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<td>6.5</td>
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<tr>
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<td>1.6 (8.9)</td>
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<tr>
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<tr>
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<td>58.9</td>
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<td>62.3</td>
<td>3.1 (8.0)</td>
<td>71.6</td>
</tr>
</tbody>
</table>

Abbreviations: CI, Confidence Interval; SD, Standard Deviation.

<sup>a</sup>There are only 291 participants in the 40 years and above analyses (130 cases, 161 controls).
younger participants were able to recall total transport-related physical activity after the age of 40 years more reliably (ICCs = 0.79 and 0.47 for the younger and older age groups, respectively).

The Bland-Altman plots of the difference against the average of the 2 questionnaires indicate that the agreement between the 2 administrations decreased as the level of transport-related physical activity increased (Figure 1).

**Discussion**

In this study we found that participants were able to recall the transport-related cycling, walking, and total activity they performed in each of the 3 age periods with fair to good test-retest reliability. The reliability of the lifetime averages for transport-related cycling, walking, and total activity were also fair to good. The reliability coefficients for total transport-related physical activity in each of the age periods and over the lifetime remained in the fair to good range even after removing the participants who reported no activity on both administrations of the questionnaire. The Bland-Altman plots suggest that recall of total transport-related physical activity became less reliable as the level of activity increased.

Although the coefficients found in this test-retest reliability study of transport-related physical activity were modest (from 0.58–0.70 for the lifetime averages), they compare well with the reliability of questionnaires that measure more recent commuting activity, as well as those that measure lifetime physical activity in other domains (recreational, occupational, and/or household, but not transport-related). Test-retest reliability studies of questions about transport-related physical activity in the Global Physical Activity Questionnaire, which measures physical activity performed in a typical week, have found correlations ranging from 0.54 to 0.98, while test-retest reliability studies of the transport-related questions in the International Physical Activity Questionnaire–Long Form, which measures physical activity performed in the last week, range from 0.60–0.89.3,12–16 Our results are also comparable with those from reliability studies

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**Figure 1** — Bland-Altman plots of the difference in total MET-hours per week between the 2 questionnaires against the average total MET-hours per week of the 2 questionnaires. The dashed line is the mean difference between the 2 questionnaires, and the shaded area indicates the 95% limits of agreement (defined as plus or minus 2 standard deviations of the mean difference of the 2 questionnaires21)
of questionnaires asking about lifetime physical activity in other domains among females. Test-retest studies of the Lifetime Total Physical Activity Questionnaire (Pearson correlation coefficient for total hours per week in recreational, occupational, and household physical activity over the lifetime = 0.74), the Chasan-Taber Physical Activity Questionnaire (ICC for lifetime average MET-hours per week in recreational and household physical activity = 0.82), the Lifetime Physical Activity Questionnaire (ICC for lifetime average MET-hours per week in recreational, occupational, and household physical activity = 0.62), and the Historical Physical Activity Questionnaire (Spearman rank correlations ranged from 0.69–0.85 for recreational physical activity performed in different age periods) have all found similar reliability coefficients to those found in this study.8–11 The similarity between our results and those from test-retest studies of questionnaires which measure recent transport-related physical activity or lifetime physical activity in other domains suggests that the questions about lifetime transport-related physical activity tested in this study have acceptable test-retest reliability.

In all the age periods and over the lifetime, transport-related cycling was more reliably recalled than transport-related walking. This is consistent with previous research that has shown that people are able to recall vigorous intensity activities more reliably than light and moderate activities.10,22 We also found that controls were able to recall their activity more reliably than cases, particularly for the cycling items, however the reliability coefficients for total transport-related physical activity in each of the age periods and over the lifetime were in the fair to good range for both cases and controls. Similarly, we found fair to good reliability for the age-period and lifetime totals among both younger and older participants.

This reliability study had some limitations which may affect the generalizability of the results. As the sampling frame for this study was a case-control study of breast cancer the reliability of these questions among males is not known, although other studies have found that males are able to recall their total physical activity more reliably than females.9,22 It is also not known how reliable these questions will be in populations with different activity patterns; the reliability of the transport-related physical activity questions in the Global Physical Activity Questionnaire and the International Physical Activity Questionnaire appear to vary greatly between countries and by education level.3,12–16 This study also had several strengths. It had a large sample size, there was an adequate time interval between administration of the 2 questionnaires, and we used the intraclass correlation coefficient rather than Pearson or Spearman correlation coefficients to assess reliability.23 In addition, this reliability study had a high response fraction and was conducted among the population of interest.

One limitation of the questionnaire is that participants are not able to report specific details of multiple intervals of activity within an age range. This may be particularly relevant to the 15–24 years age period where life transitions from school to higher education and work could result in different patterns of transport activity within this time window. However, breaking the age categories into smaller units would only increase the respondent burden, which is undesirable. Other self-administered lifetime physical activity questionnaires, such as the Chasan-Taber Physical Activity Questionnaire, the Lifetime Physical Activity Questionnaire and the Historical Leisure Activity Questionnaire, also ask about overall duration of participation rather than asking participants to specifically report multiple episodes of the same activity within an age range.8,9,11

In conclusion, we found that participants were able to recall transport-related physical activity performed in the past with fair to good reliability. The questions tested in this study appear to be useful for measuring lifetime transport-related physical activity in epidemiologic studies.

Acknowledgments

Thank you to Allyson Thomson and Pierra Rogers at the Western Australian Institute of Medical Research for their help with data collection. The BCEES is supported by a Project Grant (#572530) from the Australian National Health and Medical Research Council. TB is supported by an Australian Postgraduate Award from The University of Western Australia and a scholarship from the Lions Cancer Institute of Western Australia. LF is supported by an NHMRC Fellowship (#37614900).

References


