

Measuring physical activity in primary health care research:

Validity and reliability of two questionnaires

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ABSTRACT

Objectives

To assess the effectiveness of physical activity interventions in primary health care, measurement tools are needed that are appropriate and valid for use within primary care amongst less-active people. This study assesses the validity of two physical activity recall questionnaires within a primary care setting.

Methods

The Auckland Heart Study (AHS) Three-month Recall Physical Activity Questionnaire and the Green Script Study (GSS) Two-week Recall Physical Activity Questionnaire were adapted for self-administration within a primary care setting. Consecutive 40–79 year old patients were screened from the waiting rooms of two general practices over a five-day period. Less-active adults were invited to participate in the study. One-week test-retest reliability was assessed for the AHS questionnaire. Criterion-related validity was assessed for both questionnaires using a seven-day activity diary and seven-day pedometer record as standard comparison measures.

Results

Recruitment rates of 71% (n=36) and 67% (n=34) were achieved for the test-retest and validity study components, respectively. Intraclass and Spearman's correlation coefficients were 0.52–0.81 and 0.48–0.71, respectively, for test-retest reliability of the AHS questionnaire ($p<0.01$). Spearman's correlation coefficients were 0.50–0.74 for the AHS and 0.55–0.99 for the GSS questionnaires, when compared with the activity diary for total energy expenditure, total moderate, vigorous, and leisure moderate activity ($p<0.01$). Spearman's correlation coefficients were 0.37–0.51 for AHS and 0.61 for GSS for total moderate activity compared with the pedometer ($p<0.01$).

Conclusions

The validity and reliability of the AHS and GSS physical activity questionnaires were considered adequate for epidemiological study amongst less-active adults within a primary care setting.

Key words

Exercise, primary health care, questionnaire, validity, reliability

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Introduction

There is significant evidence that physical inactivity is a major risk factor for cardiovascular disease, diabetes, obesity, several cancers, and osteoporosis, amongst other diseases.¹ The US Surgeon General's report of 1996 recommended that all individuals should undertake thirty minutes of moderate activity on most days of the

week in order to achieve significant health benefits.¹ Consequently, initiatives to promote physical activity among sedentary adults in the setting of primary health care are becoming more prevalent internationally.^{2,3} However, the long-term effectiveness of physical activity interventions in primary care has been difficult to demonstrate in clinical trials, with few

positive results.^{3,4} One recent study was able to demonstrate differences in physical fitness long-term but unable to show the differences in regular physical activity between groups.⁵ This demonstrates the difficulty in detecting change in usual activity level and the importance of having physical activity assessment tools validated for the target population and

setting. Little et al. identified a major gap in the literature of physical activity and dietary assessment tools validated in primary care, which were suitable for use within that setting.⁶

The external validity of physical activity measurement tools is influenced by the choice of appropriate population for validation and frame of reference of exposure.⁷ Physical activity questionnaires have often been validated amongst active or educated⁸ volunteers⁹ rather than less-active or randomly selected subjects. However, less-active middle-aged and older adults visiting their family doctor make up the population of interest for testing the effectiveness of most physical activity interventions in primary health care. Activity questionnaires in the past have often been more accurate for vigorous than moderate or light activities,¹⁰ as discrete episodes of vigorous or sporting activities are easier to recall than moderate activities, which tend to be spread throughout the day. Questionnaires are needed that can estimate moderate activities more typical of less-active populations and more typical of the physical activity recommended to such a population.¹¹

To be suitable for use in primary care, questionnaires need to be self-administered and filled out within 10–15 minutes. To allow comprehensive analysis, all major areas of activities should be asked about in the questionnaires, including leisure-time, occupational, and domestic activities.¹² The questionnaires must also comply with recommended physical activity measurement data standards, which require recording type, frequency, intensity and duration of each activity.¹³

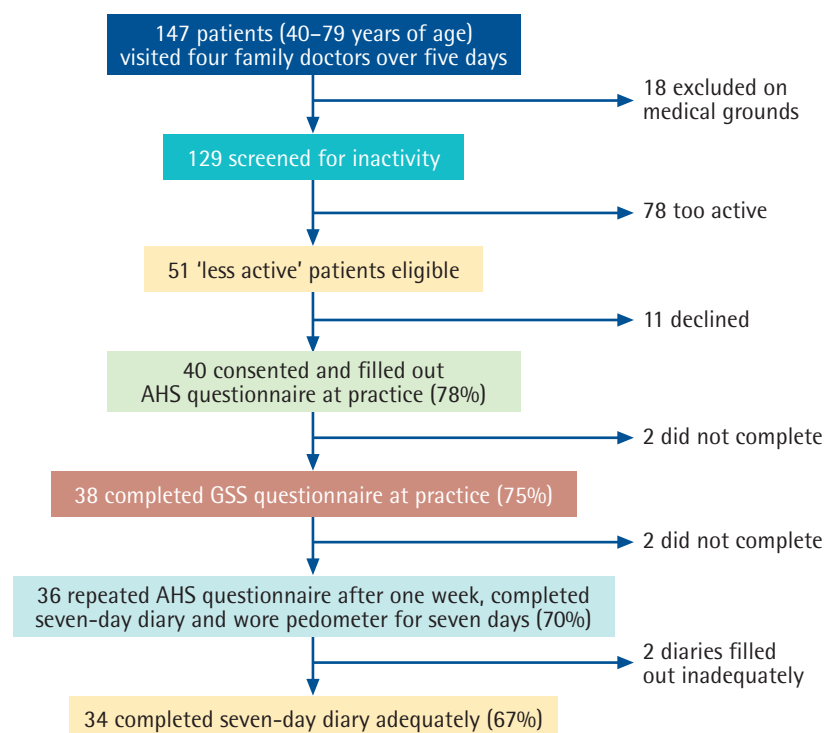
The aim of this study, therefore, was to adapt and validate two existing physical activities questionnaires to be used in an evaluation of a physical activity intervention in general practice amongst less-active adults.

Methods

Settings and participants

The questionnaire validation study took place within two general prac-

Figure 1. Participant response rate



tices within the Waikato region, each with two general practitioners and two practice nurses, just prior to the commencement of an evaluation of a physical activity intervention in general practice carried out from 2000 to 2002.¹⁴ Recruitment of patients was carried out in the waiting rooms of each practice over a five-day period. Inclusion criteria comprised 'less-active' 40 to 79-year-old patients visiting their family doctor during the week of recruitment. Patients were defined as 'less-active' if they answered 'No' to the following question: 'As a rule, do you do at least 30 minutes of vigorous or moderate exercise (such as walking or a sport), on five or more days of the week?' Exclusion criteria included presence of unstable angina, uncontrolled congestive heart failure, progressive and debilitating conditions, a serum cholesterol concentration of greater than 9 mmol/l, systolic blood pressure over 220 mmHg, or diastolic blood pressure over 120 mmHg. These criteria were based on recommended contraindications to advising exercise to the elderly.¹⁵ Patients were also excluded if they did not speak English

or were acutely injured or unwell. If the general practitioner or staff considered the candidate unsuitable for participation on medical or other grounds, the patient was not included.

Physical activity questionnaire development

The Auckland Heart Study (AHS) Three-month Recall Physical Activity Questionnaire and the Green Script Study (GSS) Two-week Recall Physical Activity Questionnaire were selected and adapted to allow self-administration within a practice setting.

The Auckland Heart Study (AHS) questionnaire

The AHS Physical Activity Three-month Recall Questionnaire was developed by Jackson¹⁶ from components of the Stanford Five City Seven-day PA Questionnaire,¹⁷ the Harvard Alumni Study PA Questionnaire,¹⁸ the Health Insurance Project (HIP) Job Questionnaire,¹⁹ and household activity questions developed by Scragg.²⁰ The AHS questionnaire has been used in the Auckland Heart Study,¹⁶ and the Auckland Blood Pressure Control

Study.²¹ Arroll validated the AHS questionnaire amongst a random sample of 113 adults in New Zealand.²² The AHS questionnaire was also used in a 12-month evaluation of the green prescription physical activity intervention in general practice that followed this validation study (unpublished data).

The Green Script Study (GSS) questionnaire

The GSS questionnaire is a two-week recall questionnaire. It has been used previously in a randomised-controlled trial with sedentary patients, evaluating the Green Script physical activity counselling programme in primary health care, over a six-week period.²³ The test-retest reliability of the GSS questionnaire had been established previously,²³ but a criterion related validation study had not been carried out.

The physical activity diary and pedometers

A seven-day activity diary²¹ and pedometer were used to assess the validity of the questionnaires. The pedometers used were Omron HJ-003, battery-powered and digitally displayed step counters. The respondents were asked to wear the pedometer and record daily number of steps on a form. During the same week respondents were also asked to fill in a seven-day activity diary by listing all moderate and vigorous leisure, domestic and occupational activities performed throughout each day. The duration and intensity of each activity was also recorded, as were the number of hours spent sleeping and resting in bed in order to calculate total energy expenditure.

Study protocol

All 40 to 79-year-old patients visiting their family doctor were screened for inactivity as they entered the practice over a five-day period. Those who fulfilled the inclusion criteria were invited to take part in the study. Participants filled out the AHS and the GSS questionnaires at the family doctor's office. Participants repeated the

AHS questionnaire one to two weeks later (mean of 11 days), commenced the seven-day activity diary and wore the pedometer for seven days.

Analysis

Test-retest reliability was assessed in the AHS questionnaire. Criterion related validity was assessed for both questionnaires using a seven-day activity diary and seven-day pedometer record as standard comparison measures. Criterion related validity assesses the relation between measurements made using an instrument and external standard reference measurements, with which a correlation would be expected.²⁴ Main physical activity outcomes included estimated total energy expenditure, total moderate, total vigorous, and leisure-time moderate activity.

Information about type, duration, frequency and intensity of each activity was recorded in the questionnaires. A MET value was established for each activity, using a standard compendium.²⁵ A MET represents the ratio of work metabolic rate to a standard resting metabolic rate of 1.0 kcal (4.184 kJ)/kg/hr.²⁶ The compendium provides an empirically-based coding system of common leisure-time, domestic and occupational activities and designates each activity with an average metabolic equivalent value (MET). Time spent sleeping or resting in bed was coded as one MET value as this represents the resting metabolic rate.²⁶ Time not accounted for, after asking about sleep, leisure, domestic and occupational activities was allocated a 1.5 MET value, assuming that time unaccounted for was spent in light activity. Activities of 3.0–4.9 MET were classified as moderate. Activities of greater than 5.0 MET were classified as vigorous.²⁷ This classification allowed the calculation of energy expenditure within each activity category, as well as total energy expenditure. Time spent in light, moderate and vigorous activities, of leisure, occupational or domestic categories was also estimated from the questionnaires and expressed as hours per week. The values calcu-

lated from the two questionnaires were compared with the validation seven-day diary and pedometer readings.

Analyses were performed using SPSS 10.0 statistical software. Spearman's rather than Pearson's correlation coefficients were calculated because of the non-parametric nature of the data. Intraclass correlation coefficients were also calculated for reliability data.²⁸ Bland-Altman plots of total energy expenditure and total moderate activity were presented as an alternative tool for testing validity.²⁹

Results

Participant characteristics

Recruitment rates of 71% (N=36) and 67% (N=34) were achieved for the test-retest and validity study components, respectively, as shown in Figure 1. Seventy-five per cent of subjects were female. The average age was 59 years (*sd* 9.4) and the mean body mass index was 28.9 kg/m² (*sd* 6.4). There was a wide range of educational levels, with 60% of participants having no secondary school qualifications and 12.5% with tertiary qualifications. Ethnic diversity was representative of both regions with 10% Maori and 90% European. Table 1 shows physical activity estimates from the seven-day diary, the two administrations of the AHS questionnaire and the GSS questionnaire.

Reliability of the AHS questionnaire

There was good test-retest reliability for total energy expenditure, total moderate and leisure moderate activity estimated by the AHS questionnaire. Intraclass correlation coefficients ($r=0.52$ to 0.81) and Spearman's correlation coefficients ($r=0.48$ to 0.71) are presented in Table 2. Test-retest reliability of the GSS questionnaire has been established previously.²³

Validity of the AHS and the GSS questionnaires

Comparison with the seven-day diary

Spearman's correlation coefficients of the AHS questionnaire and the GSS

questionnaire compared to the seven-day diary are presented in Table 3 for total energy expenditure ($r=0.59$ to 0.74), total moderate activity ($r=0.50$ to 0.72), leisure moderate activity ($r=0.52$ to 0.59), and leisure vigorous activity ($r=0.39$ to 0.99). Very few participants took part in vigorous activity. Consequently, vigorous activity correlation coefficients were more variable.

Mean paired differences of the AHS estimates compared to the seven-day diary estimates of total energy expenditure (0.29%), total moderate activity (3.96%), and leisure-time moderate activity (1.57%), were very small and not statistically significant. This is also depicted in the Bland-Altman graphs of total moderate activity and total energy expenditure of the seven-day diary compared to the AHS questionnaire in Figure 2, which shows mean discrepancies close to zero, but large standard deviations. By contrast, the GSS tends to underestimate all activity categories (by 5.93 to 43.08%) by statistically significant amounts ($p < 0.01$). These underestimates are depicted graphically in the Bland-Altman graphs in Figure 2.

Comparison with the seven-day pedometer record

Table 4 shows modest correlation between the physical activity questionnaires and pedometer records for total number of hours of moderate activity ($r=0.37$ to 0.61) and total energy expenditure ($r=0.22$ to 0.50).

Discussion

The AHS questionnaire has demonstrated good repeatability and validity when compared to the reference standards of a seven-day diary and pedometer recording, for moderate activity as well as total energy expenditure. The GSS questionnaire tended to underestimate all activity variables compared to the diary, although correlation coefficients were acceptable when compared to the seven-day diary and pedometer recordings.

Table 1. Estimated Means for Total Energy Expenditure (kcal/kg/wk), Total Moderate and Leisure Moderate Activity (hours/week) from the AHS Questionnaire, Seven-day Diary and GSS Questionnaire

	N	Mean	Std Deviation
Total energy expenditure, AHS, 1st administration	40	272.66	37.82
Total energy expenditure, AHS, 2nd administration	36	271.71	36.44
Total energy expenditure, Seven-day diary	34	272.13	27.46
Total energy expenditure, GSS questionnaire	38	258.34	32.00
Total moderate activity, AHS, 1st administration	40	15.60	15.53
Total moderate activity, AHS, 2nd administration	36	15.84	14.58
Total moderate activity, Seven-day diary	34	16.00	11.74
Total moderate activity, GSS questionnaire	38	9.49	11.57
Leisure moderate activity, AHS, 1st administration	40	3.40	4.53
Leisure moderate activity, AHS, 2nd administration	36	3.69	5.23
Leisure moderate activity, 7-day diary	34	3.82	5.28
Leisure moderate activity, GSS questionnaire	38	1.96	3.52

Participants were likely to be representative of less-active adults in primary health care, as subjects were recruited in a systematic way from the waiting rooms of two general practices. Reliability and validity studies were completed by 70% and 67% respectively of eligible patients. Educational and ethnicity backgrounds were also diverse and representative of the region.

For the purposes of this study, accepted levels of reliability and validity reported in the literature from studies using comparable physical activity measurement techniques have been used as a benchmark to measure the adequacy of results achieved here.

Spearman's correlation coefficients of 0.48 to 0.71 for test-retest reliability were found in this study. These correlation coefficients are comparable to those achieved with

other physical activity questionnaires used in large population-based studies, such as the Stanford seven-day recall,¹⁰ the EPIC core,³⁰ and College Alumnus physical activity questionnaires.³¹ The correlation coefficients found in this study are also similar to recognised physical activity questionnaires used amongst the elderly, such as the PASE questionnaire,³² and the CHAMPS questionnaire.³³ Many of these studies have used Pearson correlation coefficients, which tend to produce higher values than Spearman correlation coefficients when data are skewed, which is frequently the case with physical activity data. Despite the variability in methodologies used, correlation coefficients of reproducibility achieved in the present study are acceptable when compared to those found in the literature.

Intraclass correlation coefficients for reproducibility of 0.52 to 0.81 achieved in this study are comparable to those achieved by other physical activity questionnaires used in epidemiological research such as the Tecumseh Community Health Study questionnaire, the Five City Project questionnaire and the Baecke questionnaire.³⁴

There is reasonable correlation between the two questionnaires and the seven-day diary for total energy expenditure, total moderate activity and leisure moderate activity. Spearman's correlation coefficients ranged from 0.50 to 0.74 for the AHS questionnaire and 0.55 to 0.99 for the GSS questionnaire. Other validity studies of frequently used physical activity questionnaires have used activity diaries as a reference and achieved similar correlation coefficients.^{22,30,31}

Spearman's correlation coefficients found for the AHS and GSS questionnaires compared to pedometer were 0.37 to 0.61, ($p < 0.05$) for total moderate activity. These coefficients are comparable to those found for other physical activity questionnaires that used motion sensors as a reference, such as the PASE,³⁵ Minnesota Leisure Time,³⁶ and questionnaires reviewed by LaPorte.³⁷

The use of correlation coefficients alone to assess agreement between two measurement techniques may be misleading.²⁹ The scale or absolute values from the two measurement techniques may be quite different but still produce high correlation coefficients. For example, Table 1 shows that mean estimates of activities were very similar for the AHS and the seven-day diary, but significantly lower for the GSS, yet correlation coefficients were as high for the GSS as the AHS. To assess agreement, Bland and Altman developed a graphical depiction whereby the difference between the values obtained by each measurement technique are plotted for each individual against the mean of the two values.²⁹ The Bland-Altman graphs for total moderate activity and total en-

Table 2. Test-Retest Reliability of the AHS questionnaire: Intraclass Correlation Coefficients (ICC) and Spearman's Correlation Coefficients (SCC) for Total Energy Expenditure, Total Moderate and Vigorous Activity and Leisure Moderate Activity

	N	I.C.C.	P-value	S.C.C.	P-value
Total energy expenditure	36	0.81	0.00	0.71	0.00
Total moderate activity	36	0.74	0.00	0.59	0.00
Total vigorous activity	36	0.52	0.00	0.67	0.00
Leisure moderate activity	36	0.61	0.00	0.48	0.00

Table 3. Validity of the AHS Questionnaire and the GSS Questionnaire compared to the Seven-day Diary for Total Energy Expenditure, Total Moderate Activity and Leisure Moderate and Vigorous Activity using Spearman's Correlation Coefficients

	1st AHS* n = 34	P-value	2nd AHS* n = 32	P-value	GSS* n = 33	P-value
Total energy expenditure	0.59	0.00	0.74	0.00	0.66	0.00
Total moderate activity	0.50	0.00	0.72	0.00	0.60	0.00
Leisure moderate activity	0.52	0.00	0.59	0.00	0.55	0.00
Leisure vigorous activity	0.39	0.01	0.65	0.00	0.99	0.00

* 1st AHS: First administration of the Auckland Heart Study questionnaire.

† 2nd AHS: Second administration of the Auckland Heart Study questionnaire.

* GSS: Green Script Study questionnaire

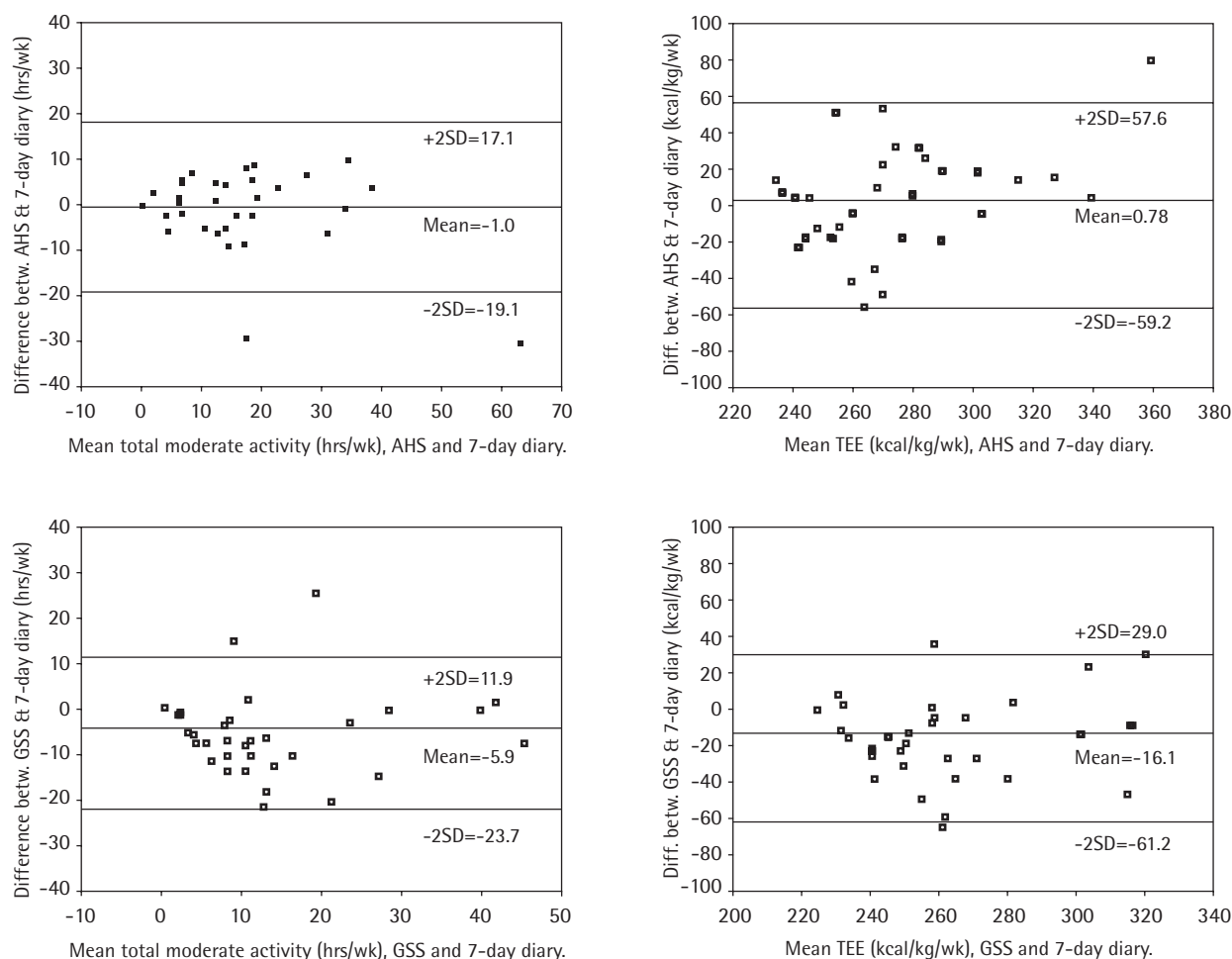
ergy expenditure for the GSS questionnaire show mean discrepancies below zero, indicating underestimation of activity compared to the diary. The Bland-Altman graphs of total moderate activity and total energy expenditure for the AHS questionnaire compared to the seven-day diary show mean discrepancies of close to zero, but large standard deviations. Consequently, the AHS questionnaire is adequate for population mean estimation and epidemiological study but may not be suitable for individual estimation of activity levels. Bland-Altman plots are rarely presented in physical activity questionnaire reliability and validity studies. When they are presented, results are often disappointing,³⁰ possibly due to the imprecision of assessing physical activity.

Activity diaries and pedometer recordings were chosen for validation comparisons in this study because of their practicality and accepted use as validation tools in the literature.³⁷⁻³⁹

However, there is a potential for correlated errors of recall bias between diaries and questionnaires. Furthermore, pedometers measure number of steps while questionnaires ask about all activities and their intensity. Consequently, this and other studies have found only modest agreement between self-reported physical activity (diaries, records and questionnaires) and motion sensors.^{35,37} Physical activity levels assessed by heart rate monitoring and doubly labelled water techniques are recognised as more accurate reference measurements.^{7,40} Even so, when these methods have been used in PA questionnaire validation studies, they often produce similar results to studies using self-report validation tools.⁴¹

This paper has addressed the shortage of physical activity questionnaires that are valid and practical for use in primary care research. In addition, total energy expenditure, as well as the component lei-

Figure 2. Bland-Altman Graphs of the Auckland Heart Study (AHS) and Green Script Study (GSS) Questionnaires compared with the 7-day Diary Estimations of Total Moderate Activity and Total Energy Expenditure (TEE)



sure-time, domestic and occupationally related activity, can be estimated from these short questionnaires. Despite being filled out by an educationally diverse and less-active population who participate in mostly light or moderate activity, levels of questionnaire reliability and validity were as high as those reported for most other physical activity questionnaires used in epidemiological research.

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Table 4. Validity of the AHS Questionnaire and the GSS Questionnaire compared to the Pedometer for Total Moderate Activity and Total Energy Expenditure using Spearman's Correlation Coefficients

	1st AHS* n = 34	P-value	2nd AHS† n = 32	P-value	GSS* n = 33	P-value
Total Moderate Activity	0.37	0.03	0.51	0.00	0.61	0.00
Total Energy Expenditure	0.22	0.22	0.49	0.00	0.50	0.00

* 1st AHS: First administration of the Auckland Heart Study questionnaire.

† 2nd AHS: Second administration of the Auckland Heart Study questionnaire.

* GSS: Green Script Study questionnaire

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Appendix 1

AHS Physical Activity Questionnaire

Date

ID Number

These questions are about your activities **during the last three months**.

1. During the last 3 months, did you engage in any **vigorous** leisure time activity long enough to make you **breathe hard** and **sweat**, at least once per fortnight? (e.g. tennis singles, dancing, jogging, squash, soccer, swimming, aqua-aerobics, exercycle, gym workout etc.)

YES ☐ NO ☐If **YES**, please record these below:

Sport or recreation	Times per FORTNIGHT	Minutes per time

OFFICE USE			
Code	Times	Min	(Met)

2. During the last 3 months did you engage in any other regular leisure time activity? (**Moderate activity**, e.g. **walking for exercise or pleasure**, bush walking, tabletennis, golf, bowling, tennis doubles, rebounder, biking etc.) (excluding gardening)

YES ☐ NO ☐

Sport or recreation	Times per FORTNIGHT	Minutes per time

OFFICE USE			

3. How many hours do you usually rest and sleep each night? _____ hours

4. What is your current occupation? _____
(If household activities only, retired, or beneficiary, go straight to Question 9)

5. How many hours do you work in an average week? _____ hours
(If more than one occupation, state how many hours at each job)

6. During the last 3 months, did you engage in any **vigorous** activity at work long enough to make you **breathe hard** and **sweat** on a regular basis? (e.g. heavy carpentry, fencing or construction work, physical labour, chopping wood, etc.)

YES ☐ NO ☐If **YES**, please record these below:

Work activity	Times per FORTNIGHT	Minutes per time

OFFICE USE			

7. During the last 3 months did you engage in any **moderate** activity at work? (e.g. delivering mail, milking cows, house painting, lifting, carrying light objects, brisk or farm walking etc.)

YES ☐ NO ☐

Work activity	Times per FORTNIGHT	Minutes per time

OFFICE USE			

8. How many minutes per day would you spend walking to and from work? _____
(e.g. from home, car, bus). And how many days per week? _____

9. Have you done any (**other**) brisk walking on a regular basis, (that is at least once per 2 weeks) in the last 3 months? e.g. to or around shops, library, or church?

YES ☐ NO ☐

If YES, minutes per day _____ Number of days walked per week _____

OFFICE USE	

10. How many hours did you spend on the following activities **in an average week**?

	Hours	Minutes
Hanging out clothes, light housework		
Mopping, vacuuming, cleaning windows or car, moving furniture, clearing out garage, or heavier housework ...		
Gardening, weeding, pruning, lawn-mowing		
Home maintenance, light carpentry, painting		
Other (specify)		

OFFICE USE	
Hrs	Min

Code	Hrs	Min

11. Compared with 12 months ago, are you now:

Less active ☐ More active ☐ The same ☐

OFFICE USE

12. If more or less active, is there any reason? _____

Appendix 2

GSS Physical Activity Questionnaire

Date

ID Number

1. Are you currently doing any regular physical activity to improve or maintain your health and fitness?

YES ☐ NO ☐

2. Please list **vigorous**, **moderate** and **light** activities that you have done in the last two weeks. These activities could be *recreational*, *around the home* or *at work*.

Vigorous activities are activities that make you perspire and pant, and usually cannot be sustained for any length of time, such as squash, running, chopping wood or physical labour.

Moderate activities are activities that make you breath hard and feel warm, such as brisk walking, lawn mowing, vacuuming, carrying light boxes or house painting.

Activity	How many times in the last 2 weeks?	How long each time?	TICK	
			Vigorous	Moderate
Recreational activities:				
Around the home:				
At work or to and from work:				

3. Is this a typical amount of activity for you?

YES ☐ No, I usually do more ☐ No, I usually do less ☐

4. What is your current occupation? _____

5. How many hours do you sleep each night? _____

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