Physical activity assessment for public health: efficacious use of the single-item measure

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Objectives: The accurate mass assessment of physical activity is essential for effective Public Health policy and practice. Combined with a desire to minimise participant burden, the self-reported single-item physical activity screening measure has become increasingly attractive and widespread. To help reduce any potential misclassification, refining this instrumentation in line with any changes in prescribed activity levels is essential to optimise accuracy. *Study design*: This study compares the levels of agreement, sensitivity and specificity for the single-item measure versus IPAQ using current physical activity recommendations. *Methods*: Agreement was assessed in a non-probability sample of 7650 adults. The κ statistic, sensitivity and specificity were used to assess agreement between the tools for classifying participants as sufficiently active for health (≥150 minutes of physical activity per week) or not, and being classified as inactive (<30 of minutes of physical activity per week) or not. *Results*: The single-item measure showed weak agreement with the IPAQ for identifying participants who met the current physical activity guidelines (κ= 0.13, 95% CI 0.12 to 0.14), sensitivity was 18.7% and specificity was 97.2%. For the classification of inactive participants it showed a moderate agreement with IPAQ (κ= 0.45, 95% CI 0.43 to 0.47), sensitivity was 74.2% and specificity was 79.7%. *Conclusions:* The single-item measure has a low diagnostic capacity compared to IPAQ. Further research is needed if it is to be used in large scale surveys and interventions where screening for sufficiently active or inactive individuals is the goal.

Keywords: physical activity, sensitivity and specificity, questionnaire,

Introduction –

Refining our understanding of physical activity measurement is central to the development of effective public health policy and programming. Moreover, accurate assessment is fundamental to intervention design, the assessment of outcomes and persuasive policy.[1] Accuracy becomes progressively augmented when data is used to propose links to health, and/or establish the scale of behaviour change within an intervention.[2] This is especially true for areas of known deprivation hampered by the effects of the social gradient.[3] Further, it is imperative to update and improve this instrumentation in line with any changes in prescribed activity levels to reduce potential misclassification.

A number of underlying issues guide the selection process for an appropriate physical activity measure. Contrary to widely held beliefs, it is not simply about choosing the most accurate tool.[4] For instance, evaluators/researchers must consider the dimensions and domains of physical activity they wish to measure, the number of participants they plan to engage with, the potential costs, personnel requirements and the speed at which results are needed.[5] Tools should also be feasible, practical, and where necessary, sufficiently sensitive to detect change. While objective measurement is generally accepted as being the most accurate approach for physical activity assessment, self-reported measures – including questionnaires – remain popular due to their feasibility, practicality and low cost.[4, 6]

For instance, a substantial amount of physical activity data that links participation to health outcomes has relied on self-report as the primary data collection method.[4, 7] Despite the fact that self-report is not considered the gold standard, many tools are valid and reliable. Validated

self-report tools can range from lengthy, in depth, quantitative history measures like the 'Modifiable Activity Questionnaire',[8] to short recall measures such as International Physical Activity Questionnaire (IPAQ)[9] and 'GPAQ',[10] to global activity questionnaires including 'Exercise Vital Sign'[11] and single-item measures.[12, 13]

Public Health agencies are becoming increasingly interested in the widespread screening of activity levels among potential participants prior to intervention.[14] Further, determining the number of people who meet physical activity guidelines is an on-going Public Health priority.[15] At the same time, screening tools that help to identify inactive individuals are equally sought-after.[16] At present, the single-item measure is one of the most widely used activity screening tools with the potential to address these issues.[12-14] The single-item measure was initially developed to assess attainment of the 2004 physical activity recommendations,[17] i.e. adults achieving ≥30 minutes of moderate to vigorous intensity physical activity (MVPA) on five or more days of the week. For assessing whether or not an individual achieved this guideline, the single-item measure demonstrated strong repeatability (r= 0.72) and moderate validity against other self-report,[14] and objective measures.[12, 13, 18]

However, the physical activity recommendations have since been updated, it is now suggested that adults undertake ≥150 minutes of moderate intensity physical activity each week.[15] Notably, this new criterion is not framed according to a 'number of days'. Nevertheless, while this change in prescribed activity appears modest, the prevalence of physically active individuals at a population level can vary markedly when classified using the 2004 or the 2011 recommendations. For example, the 'Health Survey for England 2008'[19] reported that 39% of adult men and 29% of adult women were achieving the 2004 recommendations,[17] yet when this

data was re-assessed against the 2011 guidelines, the figure rose to 65-66% for men and 53-56% for women.[20]

There is amplified potential for classification error when physical activity measures have been validated against recommendations that are now outdated. Closing the gaps in our understanding of this issue is important, there are serious Public Health consequences associated with the large scale misclassification of physically inactive adults.[4] Therefore, it is important that the sensitivity and specificity of screening tools - like the single-item measure - are as close to 100% as possible.[21] However, at present, the single-item measure is yet to be compared to any validated physical activity measure using the latest physical activity guidelines.

This study builds on previous work, and aims to assess the single-item measures levels of agreement, sensitivity and specificity against the IPAQ for assessing individuals who meet the current physical activity guidelines - classed as sufficiently active, and individuals who undertake less than 30 minutes of physical activity each week - classified as inactive.

Methods –

Study Design, Description of Participants –

The 'Leeds Let's Get Active' (LLGA) programme was developed by Leeds City Council as part of Sport England's 'Get Healthy, Get into Sport' scheme. LLGA aims to increase activity levels across the city and encourage inactive individuals to undertake at least 30 minutes

MVPA each week. The scheme supports inactive people from areas of deprivation to become active through the provision of free access to leisure centres, community sports and activities. Each week, around 150 hour long sessions are offered to participants at 17 different venues, at a variety of times.

Recruitment was open to all adults in Leeds aged ≥16 years. Prior to engaging LLGA, participants provided demographic information, and completed the single-item measure plus the IPAQ. Measures were completed either on-line or using paper based methods. At the point of analysis, a non-probability sample had recruited a data *corpus* of N=9589 participants. Participants were excluded from the analysis if they lived outside the desired catchment area (n=951), were aged <16 years old (n=910) or their contributions failed to correspond to the data cleaning guidelines of the IPAQ scoring protocol (n=78).[22] The final data set on which the analysis was undertaken contained n=7650 participants.

Ethical approval was provided by Leeds Beckett University research ethics committee, all participants provided informed consent. Data collection took place between September 2013 and January 2014.

Measurements –

Indices of Multiple Deprivation (IMD) were used as covariates to investigate the levels of agreement, sensitivity and specificity of the single-item measure compared to IPAQ. IMD scores provide a relative continuous measure of deprivation at lower super output area (LSOA) level. Areas are ranked on seven different dimensions of deprivation and an overall composite

measure of multiple deprivation. There is no fixed number on the scale which catalogues an area as deprived or not. However, participants presenting the lowest ~ 20% IMD scores are deemed to be living in the *'most deprived'* LSOA's compared to the remaining ~80% living in the *'least deprived'* LSOA's.[23]

Physical activity data was captured using two self-report instruments; (i) the short version IPAQ and (ii) a single-item activity question.

IPAQ is a short recall questionnaire providing a quick assessment of the total volume of physical activity classified by dimension of intensity or domain (type or mode).[5] Originally developed to measure health enhancing physical activity for population surveillance, IPAQ can be used as an evaluation tool in interventions to assess individual energy expenditure and activity status.[22] IPAQ has been validated for use in community settings with adults, older adults and ethnic minority groups.[9, 24] MET-minute/week expenditure was calculated by summing the relevant activity dimension's and domains for each participant. The number of days featuring these activities was multiplied by the estimated time per day spent doing each one. The relative energy expenditure of each activity was taken into account by multiplying weekly minutes by a MET value (multiples of the resting metabolic rate) recommended by the IPAQ scoring protocol (walking was scored as 3.3 METs, moderate intensity activity was 4 METs and vigorous intensity activity and 8 METs).[9]

The single-item measure has been validated for use against accelerometers[12] and GPAQ demonstrating strong reproducibility (r =0.72) and modest concurrent validity (r= 0.53).[14] An

open response scale to the question was used, with valid responses ranging from 0 to 7 days. The wording of the single-item question was.[14]

"In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate. This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job"

Statistical Analysis –

Descriptive statistics show the socio-demographic profiles and activity characteristics of participants. The Shapiro-Wilk test of normality determined distribution. As data were not normally distributed, Mann-Whitney tests calculated differences in days of physical activity per week and total MET-minutes/week by gender and IMD (*'most deprived'* vs. *'least deprived'*). Kruskal-Wallis tests measured differences, and the Jonckheere-Terpstra test identified trends in days of physical activity per week and total MET-minutes/week by age category.

Participants were grouped into either inactive or sufficiently active categories according to activity scores from the single-item measure and IPAQ.[25] A participant was classified as inactive if they reported a zero on the single-item measure, or no days of MVPA totalling less than 120 MET-minutes/week on the IPAQ. The cut point for being classified as sufficiently active was achieved if participants reported 5 days or more on the single-item measure, or reported 5 or more days of any combination of walking/MVPA achieving a minimum of at least 600 MET-minutes/week on the IPAQ.

Cohen's kappa (κ) determined the magnitude of agreement; sensitivity and specificity were calculated to assess diagnostic performance. Analysis looked at two outcomes. First was the agreement between the single-item measure and IPAQ for detecting whether or not participants were sufficiently active - achieving the current physical activity recommendations of ≥150 minutes of MVPA per week.[15] The second outcome was the agreement between the single-item measure and the IPAQ for classifying participants as inactive (achieving <30 minutes of MVPA per week). Percent agreement was also reported.

Across the analyses, κ scores of <0.2 were regarded as weak, 0.21-0.4 fair, 0.41-0.6 moderate, 0.61-0.8 strong, and 0.81-1.0 very strong.[26] For all inferential tests, a *p* value of ≤.05 or less was taken to be statistically significant. All analyses were conducted using SPSS for windows version 21.0.

Results –

Analysis was undertaken with n=7650 participants. Table 1 shows their socio demographic characteristics. Female participants dominated the sample (64.6%). The majority of participants (53.8%) were aged <40 years, however, over one quarter of participants were aged ≥50 years - classified as older adults. Valid postcodes were provided by 96.2% (n=7357) of participants; these were used to determine IMD. In total, n=1431 participants were categorised as living in the *'most deprived'* areas and n=5926 participants were categorised as living in the *'least deprived'* areas.

Single-Item Outcomes –

Based on the single-item measure (Table 2), 31.2% of participants were classified as inactive - undertaking zero days of physical activity each week. The single-item measure categorised 12.6% of participants as achieving the current physical activity guidelines – undertaking 5 or more days each week. Days of physical activity reported by males were significantly higher compared to females (U = 6317679, z = -4.094, p <.001, r = -.05), and days of physical activity reported by the *'most deprived'* participants were significantly higher compared to the *'least deprived'* participants (U = 3804821, z = -6.174, p <.001, r = -.07). Days of physical activity were significantly affected by age (H [6] = 80.951, p < .001). Jonckheere's test revealed significant trends in the data; as age increased so too did median days of physical activity (J = 12156854, z = 2.956, r = 0.03).

IPAQ Outcomes –

IPAQ classified 20.3% of participants as inactive and 62.0% as sufficiently active. Table 3 shows the median values and the interquartile range for each dimension (intensity and type) of the IPAQ. Participants reported a median value of 1074 MET-minutes/week of MVPA signifying a sufficiently active cohort. Median values for vigorous and moderate MET-minutes/week suggest that the majority of participants undertook no vigorous or moderate physical activity each week. Further, MET-minutes/week values indicate that walking made up a sizable proportion of total weekly energy expenditure.

Males reported significantly more MET-minutes/week of MVPA (*Mdn* = 13986) compared to females (*Mdn* = 986), U = 6148676, z = -5.849, p <.001, r = -.07. Participants classified as

'most deprived' reported significantly more MET-minutes/week of MVPA (*Mdn* = 1272) compared to the *'least deprived'* (*Mdn* = 1020), U = 3945335, z = -4.098, p <.001, r = -.05. MET-minutes/week were significantly affected by age (H [6] = 61.760, p <.001), Jonckheere's test revealed no significant trends in the data. Further, daily sitting time reported by participants suggests high levels of sedentary behaviour.

Levels of Agreement –

Table 4 shows the precent agreement, levels of agreement, sensitivity and specificity for the two measures. Overall agreement between the single-item measure and IPAQ for detecting sufficiently active participants - i.e. those achieving the current physical activity recommendations - was 49.1% with a κ statistic of 0.13 (95% Confidence Interval [CI] 0.12 to 0.14). The single-item measure correctly identified 18.7% of participants that met the current physical activity guidelines (sensitivity) and 97.2% who did not meet the current physical activity guidelines (specificity). The κ statistic and sensitivity was generally higher for males, older adults and those classified as *'least deprived'* by IMD. Further, overall agreement between the single-item measure and IPAQ for identifying inactive participants was 78.7% with a κ statistic of 0.45 (95% CI 0.43 to 0.47). The single-item measure demonstrated 74.2% for sensitivity and 79.7% for specificity. The κ statistic and sensitivity levels were higher for males compared to females, younger age groups compared to older ones, and participants classified as living in the *'least deprived'* areas by IMD.

Discussion –

This study investigated the levels of agreement, sensitivity and specificity of the single-item measure compared to IPAQ, using contemporary physical activity recommendations. The main findings indicated that the single-item measure had a low diagnostic capacity and was not sufficiently sensitive to detect physically active participants. However, the single-item measure fared substantially better at diagnosing inactive participants. Findings from this study may be of interest to Public Health systems, policy makers, program evaluators and researchers. Results highlight that the single-item measure - a widely used physical activity screening tool – has limited capacity to achieve its original aims.

The sample was predominantly female, <50 years old and presented IMD scores across the spectrum. Using both measures, results reflect findings from other national evidence that males report being more active than females.[15] However, contrary to evidence concerning physical activity and age,[15] in this cohort, older adults reported more activity than younger adults. It is possible that these results were influenced by LLGA attracting active older adults who were displacing other pre-existing activity, whereas younger less-active adults may have used LLGA to displace sedentary behaviour.[27, 28] Further, higher levels of deprivation, assessed using IMD have previously been associated with lower levels of activity.[29] Nonetheless, in this study, participants living in the *'most deprived'* areas were more active compared to participants from the *'least deprived'* areas. The disparity between these findings and our results may in part be due to the comparatively high levels of deprivation found within this sample. This issue may be important in studies addressing impacts of the built environment on physical activity behaviour.

Based on the single-item measure, <15% of participants achieved the current physical activity guidelines compared to >60% identified by IPAQ. Across the two measures, for determining sufficiently active participants, the precent agreement was 49.1%. Previous studies, using earlier activity recommendations[17] showed agreement for the single-item measure ranging from 58% against accelerometers,[12] to 28% for short recall measures.[14] As percent agreement is limited and inflated by chance agreements, use of kappa (κ) is also recommended to determine the level of agreement. In the current sample, κ was 0.13, signifying that the single-item measure was a weak predictor of sufficiently active participants versus the IPAQ, this is considerably lower than in previous research.[12] The single-item measure correctly diagnosed less than one in five participants as sufficiently active - using current physical activity recommendations. This questions its ability to achieve its original aims and suitability for future use.

This reduced diagnostic capacity may be partially mediated by changes in the physical activity recommendations from ≥30 minutes MVPA on five or more days a week [17] to a cumulative ≥150 minutes MVPA each week.[15] Whilst the changes appear negligible, the single-item measures open scale response can establish the number of days an individual achieves ≥30 minutes MVPA each week, however, it is unable to provide an accurate estimate of total weekly activity.[12] The potential for misclassification and under reporting of physically active individuals can be seen using the example of an individual, screened by the single-item measure, who achieves 151 minutes of MVPA split equally over two days each week. Against the 2004 recommendations the single-item measure was validated against, the individual would select 2 days and be correctly screened insufficiently active. However, against the 2011 recommendations, they achieve the ≥150 minute MVPA benchmark and are sufficiently active.

Yet they would be classified as insufficiently active by the single-item measure reporting just two days MVPA a week.

Regarding the diagnosis of inactive individuals, the benchmark for being classified as inactive is set at <30 minutes of MVPA per week. The open scale response of the single-item measure means that participants reporting 0 days are classified as inactive. However, it is possible that an individual could be achieving 25 minutes MVPA every day, effectively making them sufficiently active (175 minutes MVPA each week) against the 2011 recommendations.[15] Yet, if they correctly report 0 days on the single item measure, they would be classified as inactive.

To our knowledge, percent agreement, levels of agreement and sensitivity and specificity between the single-item measure and IPAQ on the classification of inactive individuals have not been reported elsewhere. The single-item measure categorised ~30% of participants as inactive compared to ~20% using IPAQ. For this diagnosis, percent agreement between the single-item measure and IPAQ was 72.4% with a κ statistic of 0.46 (95% CI 0.44 to 0.48). These findings suggest that it is a moderate predictor of inactivity, with moderate consistency of agreement between the two measures. The single-item measure demonstrated 72% for sensitivity, highlighting that it correctly diagnosed nearly three quarters of participants as inactive. Furthermore, the levels of agreement, sensitivity and specificity for this categorisation remained when adjusting for IMD. Although these results are promising, given the potential for misclassification due to the cumulative nature of the current physical activity recommendations, further validation is needed.

This study has a number of limitations. The use of a non-probability sample may limit the external validity of the findings.[30] For instance, males were underrepresented accounting for 35% of the sample. Additionally, there were relatively few demographic markers which may in turn lower the generalizability and external validity. Further, both measures of physical activity rely on self-report, meaning that response bias may have caused some level of misclassification.[31] For example, even though IPAQ was used to compare diagnostic capability with the single-item measure, it is not considered the gold standard indicator and may also misclassify participants. However, these limitations should be measured against the strengths which include the sample size. Indeed our sample of 7650 can be compared to samples of 133,[12] 318,[13] and 480[14] in other studies. This is also the first study to compare the single-item measure to any validated activity measure against contemporary guidelines. Future studies should assess the diagnostic capacity of the single-item measure against more sensitive, objective measures and its responsiveness over an intervention period.

Conclusions –

The assessment of physical activity for Public Health can be a moveable feast, fluctuating as recommendations and classification boundaries are amended and new methods of assessment are developed. Therefore, the process of physical activity measurement requires continuous refinement. Given the voracious appetite of evaluators and researchers for speedily assessing physical activity status, this work develops and informs our understanding of the single-item physical activity measure. Findings from this study suggest that in its current form, the single-item measure is no longer an appropriate screening tool. Further validation is needed to confirm the suitability of the single-item measure for large scale surveys and interventions where screening for sufficiently active or inactive individuals is the goal.

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Table 1: Socio demographic characteristics of participants

		% of Participants (n)
Socio Demographics		
Gender (n=7646)	Male	35.4 (2709)
	Female	64.6 (4937)
Age (n=7650)	16-19	5.1 (391)
	20-29	20.4 (1558)
	30-39	28.3 (2163)
	40-49	19.9 (1524)
	50-59	12.1 (922)
	60-69	10.5 (800)
	70+	3.8 (292)
IMD (n=7357)	Decile 1 – Highest IMD	9.9 (728)
	Decile 2	9.6 (703)
	Decile 3	10.5 (775)
	Decile 4	9.2 (675)
	Decile 5	9.4 (689)
	Decile 6	11.4 (836)
	Decile 7	8.8 (645)
	Decile 8	10.8 (797)
	Decile 9	9.5 (698)
	Decile 10 – Lowest IMD	11.0 (810)

Note: IMD = Indices of Multiple Deprivation,

Table 2: Single-item derived activity characteristics

		% of Participants (n)
Single-item Activity Question		
MVPA Days/Week (n=7650)	Zero Days	31.2 (2383)
	One Day	18.1 (1383)
	Two Days	17.3 (1323)
	Three Days	13.4 (1025)
	Four Days	7.4 (569)
	Five Days	6.6 (503)
	Six Days	1.8 (141)
	Seven Days	4.2 (323)

Note: MVPA = Moderate and Vigorous Physical Activity,

Table 3: IPAQ derived characteristics of respondents

		Median Value (IQR)
IPAQ Profile		
MVPA	Median MET-Minutes/week	1074 (240, 2773)
Vigorous Activity	Median MET-Minutes/week	0 (0, 952)
Moderate Activity	Median MET-Minutes/week	0 (0,480)
Walking	Median MET-Minutes/week	396 (50, 1188)
Sitting Time	Median Minutes/day	300 (180,480)

Note: MVPA = Moderate and Vigorous Physical Activity, IQR = Inter Quartile Range

Table 4: Percent agreement, sensitivity and specificity of the single-item measure compared with IPAQ

	≥150 Minutes MVPA per week				***<30 minutes MVPA per week***			
	% Agreement	*Sensitivity (%)*	*Specificity (%)*	*κ (SE)*	*% Agreement*	*Sensitivity (%)*	*Specificity (%)*	*κ (SE)*
All (n=7650)	49.1	18.7	97.2	0.127 (.005)**	78.7	74.2	79.7	0.451 (.011)**
Gender								
Male (n=2709)	47.4	20.9	97.0	0.134 (.009)**	80.9	74.7	82.6	0.499 (.019)**
Female (n=4937)	49.2	17.4	97.3	0.122 (.007)**	77.5	73.9	78.4	0.426 (.014)**
Age								
< 19 (n=391)	47.1	20.9	94.9	0.120 (.026)**	81.6	74.7	83.6	0.523 (.049)**
20-29 (n=1558)	44.9	17.3	96.7	0.103 (.011)**	78.6	77.0	78.9	0.433 (.025)**
30-39 (n=2163)	49.7	17.6	97.8	0.128 (.010)**	77.6	75.1	78.7	0.445 (0.21)**
40-49 (n=1524)	52.1	18.1	97.0	0.134 (.014)**	79.0	75.9	80.1	0.500 (.024)**
50-59 (n=922)	51.8	20.9	98.4	0.161 (.017)**	76.5	74.1	77.1	0.430 (.031)**
60-69 (n=800)	42.6	19.3	97.1	0.107 (.014)**	80.5	65.5	83.0	0.376 (.039)**
70+ (n=292)	49.3	25.3	96.9	0.163 (.030)**	81.5	56.5	86.2	0.380 (.068)**
IMD								
Decile 1 (n=728)	46.0	22.8	98.2	0.142 (.016)**	83.5	67.8	85.7	0.413 (.043)**
Decile 2 (n=703)	44.7	14.8	96.9	0.089 (.016)**	79.2	68.6	81.4	0.402 (.040)**
Decile 3 (n=775)	49.2	15.7	97.5	0.112 (.017)**	78.5	77.7	78.6	0.458 (.034)**
Decile 4 (n=676)	47.2	20.0	96.7	0.126 (.018)**	78.6	72.1	80.1	0.429 (.039)**
Decile 5 (n=689)	49.2	20.8	97.3	0.142 (.019)**	79.7	77.9	80.1	0.480 (.036)**
Decile 6 (n=836)	50.0	18.5	97.6	0.134 (.017)**	77.2	75.9	77.7	0.461 (.032)**
Decile 7 (n=645)	47.8	19.4	96.6	0.125 (.019)**	80.6	70.9	83.2	0.479 (.039)**
Decile 8 (n=797)	49.8	20.5	95.8	0.134 (.019)**	76.3	70.6	78.0	0.417 (.034)**
Decile 9 (n=698)	51.6	18.8	97.9	0.144 (.019)**	77.5	73.6	78.7	0.450 (.036)**
Decile 10 (n=810)	48.4	15.1	97.3	0.104 (.016)**	76.9	81.3	75.6	0.462 (.032)**

Note: MVPA = Moderate and vigorous physical activity, IMD = Indices of Multiple Deprivation, κ =Kappa, SE = Standard Error, ** = p <.001