Archives of Psychiatric Nursing xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Archives of Psychiatric Nursing

journal homepage: www.elsevier.com/locate/apnu

Selection, Use and Psychometric Properties of Physical Activity Measures to Assess Individuals with Severe Mental Illness: A Narrative Synthesis

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A B S T R A C T

This research provides a critical consideration of the outcome measures used to assess physical activity in individuals with severe mental illness. A narrative synthesis was utilised to provide a simple juxtapose of the current research. A sensitive topic-based search strategy was conducted in order to identify studies that met the eligibility criteria. Fifty two studies met the inclusion criteria and 5 were identified specially as validation studies. The current research identified several methodological shortcomings. The justification and choice of outcome measure used is often weak and only five studies have validated a specific outcome measure of physical activity. Within these validation studies, the validation process often lacked a consideration of agreement between measures. Accelerometers have been most frequently used as a criterion measure, notably the RT3 tri-axial accelerometer. Objective based measures may be best placed to consider physical activity levels, although, methodological considerations for the utilization of such tools is required. Self-report questionnaires have benefits for use in this population but require further validation. Researchers and clinicians need to carefully consider what outcome measure they are using and be aware of the development, scope and purpose of that measure.

Severe mental illness (SMI) is a term that relates to all mental disorders, with the largest diagnosis within the description as schizophrenia. The term severe refers to the fact that the mental illness interferes with daily functioning and that illness symptoms are reoccurring. In addition to this, the condition is characterized by the need to consider safety (for others, abuse from others, & self harm) and the need for informal (e.g., friends) and formal (e.g., support services) care (Cohen, Singh, & Hague, 2004; Department of Health, 1995; Department of Health and Human Services, 1999). Physical activity and exercise are important modifiable lifestyle choices for individuals with SMI and play a role in preventing and treating cardio-metabolic risk factors (Vancampfort et al., 2010a). Increasing physical activity can benefit the individual's physical and mental health (Gorczynski & Faulkner, 2011). Monitoring physical activity levels is important for surveillance and for assessing the effectiveness of physical activity interventions. Investigation of the dose–response relationship between physical activity and physical and mental health outcomes is dependent on a reliable and valid responsive assessment of physical activity.

The current understanding of the patterns and levels of physical activity is based on a range of different outcome measures. The different tools capture variable information and it cannot be assumed that this information is accurate or provides a complete picture of physical activity patterns. Outcome measures that capture physical activity are largely represented by two groups, including self-report questionnaire (SRQs) and objective based measures (OBMs). SRQs (self or interviewer administered) are used as a primary way of measuring physical activity in studies in individuals with SMI. Such measures provide a cheap and easy way to collect physical activity data from a large number of people in a short time. In the last few years there has been a surge of research studies (Sharpe, Stedman, Byrne, & Hills, 2006a; Soundy, Taylor, Faulkner, & Rowlands, 2007; Yamamoto et al., 2011) that have considered the use of OBMs (measures including; calorimetric measures, physiological markers, motion sensors and monitors and direct observation). One of the reasons for this increase in OBMs is to provide a clearer and objective picture of physical activity patterns. This is partly as a response to the limitations apparent when considering SRQs. For example, recall bias by participants (Soundy et al., 2007), the use of a summative scale which is not comparative with other measures, or not illustrative of the four primary domains (Warren et al., 2010) of physical activity (frequency, intensity, time or type) undertaken. In addition, there is variability in the time scale considered as well as the questions contained within the instrument (a factor partially influenced by the original design of the scale and

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http://dx.doi.org/10.1016/j.apnu.2013.12.002

population it was validated on). Finally, not all SRQs have been validated against an OBM or a gold standard measure and the SRQs that have been fully validated may have not considered agreement between measures. This is an essential aspect that should be included in validation studies (Bland & Altman, 1999, 2010; Plasqui & Westerterp, 2007; Warren et al., 2010).

Whilst the selection of a method to assess physical activity is always a trade-off between degree of validity and feasibility, the chosen method, nevertheless, must be suitable for the research aims. The choice of an inaccurate method will lead to crude and misleading outcome data (Warren et al., 2010). This provides the impetus for research which asks the questions 'can we trust what the literature tells us about the patterns of physical activity in individuals with SMI?' and, 'what are the potential limitations of this literature?' Traditional reviews may be limited in addressing these questions and other approaches may be indicated. Notably, a review is needed that is able to consider; (1) the measurement properties of outcome measures, (2) the accuracy of the methodological procedures and processes undertaken by previous studies the include individuals with SMI (3) a process that can generate recommendations for future research. Thus, the requirements for this review are well suited to a more novel approach to data extraction and synthesis in order to examine a specific aspect of the methodology of previous literature and provide an in depth consideration of the previous tools used.

AIMS OF THE STUDY

The primary aim is to provide a critical consideration of the application of research tools used to assess physical activity in individuals with SMI. Secondary aims include (a) establishing the quality of studies that have attempted to validate SRQs in this population and (b) generating recommendations for good practice for the use measurement tools in this population.

METHODS

A narrative synthesis review was conducted according to the general guidance (Pope, Mays, & Popay, 2007). This type of review offers a transparent and systematic means of bringing together evidence from studies which are heterogeneous in a number of ways. Various techniques and tools are applied to, firstly, integrate findings from selected studies and, secondly, interpret the meaning of the results enabling new understanding of the topic under scrutiny to emerge (Rodgers et al., 2009). The process is conducted in 4 stages: 'Developing a theory'; 'Developing a preliminary synthesis'; Exploring relationships', and 'Assessing the robustness of the synthesis' (Pope et al., 2007).

Developing a Theory

This paper sought to conduct a review based on the theoretical assumption that physical activity levels can be measured in people with SMI using measures that are reliable and valid but that methodological weakness in some published literature, arising from inadequate consideration of the measurement properties of tools used, may undermine conclusions relating to physical activity levels in people with SMI. The use of narrative synthesis seeks to explore this assumption generating recommendations for future use of physical activity measurement tools in this population.

Developing a Preliminary Synthesis

A systematic search of the literature was conducted focussed to the theoretical assumptions outlined above. The focus of the search was to locate literature that has measured the patterns of physical activity within a cross sectional or interventional study.

Information Sources and Search Strategy

Electronic searching was conducted, from database inception to August 2012, using Cochrane Library, CINAHL, EBSCO, EMBASE, Medline, PEDro, PubMed, PsychINFO, SPORTSdiscus, Science Citation Index and Social Science Citation Index; ZETOC databases; selected Internet sites (e.g. CSP) and Indexes (Turning Research into Practice, Health Services/Technology Assessment, PUBMED); hand searches of key journals; unpublished research: British National Bibliography for Report Literature, Dissertation Abstracts, Index to Scientific and Technical Proceedings, National Technical Information Service, System for Information on Grey Literature.

Separate searches were conducted for each identified SRQ and alternate terminology for generic SRQs, to allow statistics to be reported against individual OMs. Each search strategy combined key terms for the population and the SRQ of interest (Mokkink et al., 2012), key terms and terminology used in the search strategy replicated that used in a previous systematic review (Prince et al., 2008). Hand searches were made on the reference lists of articles including recent review articles related to physical activity and SMI (Prince et al., 2008; Scott & Happell, 2011; Vancampfort et al., 2010b, 2011b) and of articles included in the current study.

Eligibility Criteria (Inclusion and Exclusion Criteria) for the Review

An article was included in the review when: a) the study population and the study sample included people identified as having a formal diagnosis of SMI (Cohen et al., 2004; Department of Health, 1995; Department of Health and Human Services, 1999); b) the article reported assessment of physical activity using a SRQ or OBM, including validation studies, cross sectional studies or baseline findings of intervention studies; c) the article was published in English; d) articles used a tool that could express the three fundamental dimensions of physical activity (frequency, duration and intensity) (Warren et al., 2010) were included, ideally, the inclusion of the type of physical activity was also included (Armstrong & Welsman, 2006). This was selected to provide a greater comparison between the different SRQ and OBM tools used. Exclusion criteria were defined as: a) studies available only in an abstract, conference proceeding or thesis, or, summarized in a book; b) studies whose primary focus was not on physical activity, as this may limit the justification of the tool selected; c) reviews, including systematic reviews, narrative reviews, critical appraisals; d) articles reporting other aspects of physical activity such as factors contributing to the level of physical activity and/or qualitative research; e) research orientated to the fitness level of individuals with SMI. There was no restriction on publication date.

Study Selection Process

The full text of an article was retrieved when, following discussion between two reviewers (AS/CR), it was agreed that it could not be unequivocally excluded based on its Title and Abstract (Center for Reviews, Dissemination (CRD) (CRD), 2009). An article was included when the reviewers agreed that it satisfied all eligibility criteria. The number of articles identified at each stage was recorded for each outcome (see Fig. 1). Because of the number of studies identified the included and excluded studies are identified within a table (see Table 1).

Tools and Techniques Used to Inform Preliminary Synthesis

Three specific techniques were used to bring findings together for comparison and subsequent interpretation:

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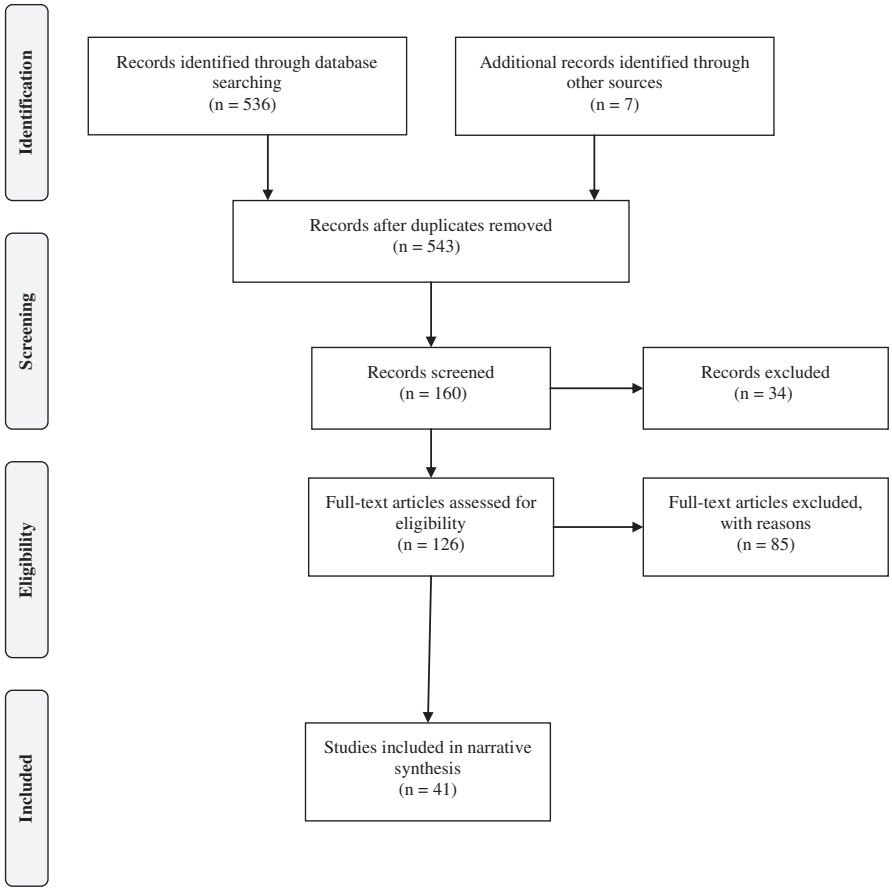

Fig. 1. Providing a PRISMA (Moher, Liberati, Tetzlaff, Altman, 2009) flow Diagram of the selection process.

Technique 1: A Summary of Outcome Measures Used

Articles that met the inclusion criteria were grouped into either studies utilizing OBMs or SRQs. The outcome measures used were then tabulated to summarize information about each outcome measure. This approach was undertaken in order to give the reader (clinician or researcher) an understanding and ability to compare different tools. Two tables (Tables 2 and 3) were designed to provide information about the aim and structure of the tools, as well as technical details (e.g., the technology used and the physical size of the OBM). The SRQ table was designed to identify the original validating article together with any research that has validated the tool in a SMI population. The OBM table was designed to give an overview of the tool (physical properties, technical specification and data collection ability) and identify any initial validation studies and subsequent validation studies in SMI.

Technique 2: Methodological Quality of Studies that Report Using an Outcome Measure

SRQs and OBMs were tabulated separately using different parameters of methodological quality. The methodological criteria were developed according to previous detailed procedures (Janney, 2012; Powell, Jones, & Rowlands, 2003; Powell & Rowlands, 2004; Rowlands, Thomas, Eston, & Topping, 2004; Sharpe, 2007; Soundy, 2007). Based on this a set of criteria were established for the included studies. We identified 6 criteria for the OBM studies which research studies considering SMI and physical activity should identify when using a tool. These criteria included (choice of tool, identification of previous validation studies, calculations for output given, reference to studies that provide detail about how output was obtained, identification of intensity of physical activity, calibration/inter-monitor variability). We identified 7 criteria for the SRQ studies which research studies considering SMI and physical activity should identify when using a tool. These criteria included (choice of tool, citation of the original validation study, citation of additional validation studies, calculation for output given, reference to studies that detail output calculations, identification of values that represent difference intensities of physical activity, appropriateness considered).

Tabulation (Tables 4 and 5) of these criteria with vote counting, generating a summative score for each study, was identified as a way to provide a total score that related to reporting quality of the article and potential for error. A higher score represented a greater quality in reporting and less potential for error. The tables enabled visual comparisons of specific aspects of included studies and provided a common rubric to use (an important aspect of the narrative synthesis).

Technique 3: Validity and Reliability of Outcome Measures

The Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) approach (Mokkink et al., 2012) was undertaken to assess the validation of studies that have used SRQs or OBMs in individuals with SMI. This checklist provides four scores for requirements of the different validity and reliability components. These include excellent, good, fair and poor. The scores of 'excellent' and 'good' infer adequate methodological quality, where as the scores of 'fair' indicates that there is doubt in the methodological quality of that aspect and an item scored as 'poor' indicates that the methodological aspect is not adequate (Terwee et al., 2012). Scores that are fair or poor are reported and

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Table 1
Details of the Included and Excluded Studies.

	Reference
Included studies (with focus)	
5 studies validated an SRQ in a sample of individuals with SMI	Dubbert, White, Grothe, O'Jile, & Kirchner, 2006; Faulkner, Cohn, & Reminghton, 2006; Lindamer et al., 2008; Ma, Chiang, Yen, Huang, & Tsai, 2011; Soundy, 2007.
1 study validated the RT3 accelerometer	Sharpe et al., 2006a.
16 studies used as part or in full an OBM to capture physical activity	Berle, Hauge, Oedegaard, Holsten, & Fasmer, 2010; Farrow, Hunter, Wilikinson, Green, & Spence, 2005; Gothelf et al., 2002; Hauge, Berle, Oedegaard, Holsten, & Fasmer, 2011; Janney et al., 2008; Jerome et al., 2009; McCormick et al., 2009; McCormick et al., 2008; McKibbin et al., 2006; Scheewe, 2008; Scheewe et al., 2011; Sharpe et al., 2006a; Wichniak et al., 2011; Yamamoto et al., 2011.
19 studies utilised SRQs	Archie et al., 2007; Arbour, Faulkner, & Cohn, 2010; Brown, Birtwistle, Roe, & Thompson, 1999, Brown, Goetz, Van Sciver, Sullivan, & Hamera, 2006; Dubbert et al., 2006; Ellingrod et al., 2011; Elmslie, Mann, Silverstone, Williams, & Romans, 2001; Faulkner et al., 2006; Lassenigus, kerlind, Wiklund-Gustin, Arman, & Söderlund, 2013; Lindamer et al., 2008; McLeod, Jaques, & Deane, 2009; Osborn, Nazareth, & King, 2007; Ratliff et al., 2012; Soundy, 2007; Ussher, 2003; Ussher, Doshi, Sampuran, & West, 2011; Van Citters et al., 2010; Vancampfort, Probst, Knapen, Carraro, & De Hert, 2012.
Excluded studies (with reason)	
55 did not use an outcome measure that provided an assessment of the three fundamental domains of physical activity	Acil, Dogan, & Dogan, 2008; Adams, 1995; Aquila, 2000; Archie, Wilson, Osborne, Hobbs, & McNiven, 2003; Ball, Coons, & Buchanan, 2001; Barton, Griffin, & Pretty, 2012; Beebe et al., 2005; Bobes et al., 2010a,b, Bobes, Arango, Garcia-Garcia, & Rejas, 2010b; Brill et al., 2007; Brunero & Lamont, 2010; Buhagiar, Parsonage, & Osborn, 2011; Centorrino et al., 2006; Charmove, 1986; Chuang, Mansell, & Pattern, 2008; Crone et al., 2004; Daumit et al., 2005; Davidson et al., 1999, 2001; Dodd, Duffy, Stweart, Impey, & Taylor, 2011; Duraiswamy, Thirthalli, Nagendra, & Gangadhar, 2007; Farrow, Hunter, Haque, & Spence, 2006; Faulkner, Taylor, Munro, Selby, & Gee, 2007; Fogarty, Happell, & Pinikahana, 2004; Gimino & Levin, 1984; Harmatz, 1968; Heimberg, Gallacher, Gur, & Gur, 1995; Hendryx, Green, & Perrin, 2009; Hutchinson, Skrinar, & Cross, 1999; Joukamaa et al., 2006; Klein, Steele, Simon, & Primavera, 1972; Lempp et al., 2009; Martin-Sierra et al., 2011; McCreadie, 2003; McDevitt, 2005; McDevitt, Wibur, Kogan, & Briller, 2005; McGale, McArdle, & Gaffney, 2010; McKay & Pelletier, 2007; Moore & Crum, 1969; Park, Usher, & Foster, 2011; Patterson et al., 1996; Pelpham, Campagna, Ritvo, & Birnie, 1993; Poulin et al., 2007; Samele et al., 2007; Sharpe, Stedman, Byrne, Wishart, & Hills, 2006b; Skrinar, Unger, Hutchinson, & Faigenbaum, 1992, Skrinar, Huxley, Hutchinson, Menninger, & Glew, 2005; Sletten, Cazenave, & Gershon, 1967; SØrensen, 2006; Strassnig, Brar, & Ganguli, 2011; Thyer, Irvine, & Snata, 1984; Upper & Newton, 1971; Ussher, Cheeseman, & Faulkner, 2007; Vancampfort et al., 2011a,b,c.
4 studies used pedometers as measures	Beebe & Harris, 2012; Kane, Lee, Sereika, & Brar, 2012; Methapatara & Srisurapanont, 2011; Richardson, 2005.
3 studies had a primary focus on motor activity alongside other variables rather than measuring physical activity	Walther et al., 2011; Walther, Koschorke, Horn, & Strik, 2009a,b, Walther et al., 2009b.
11 studies that reported physical activity without a specific SRQ	Arango et al., 2008; Bobes et al., 2010a,b; Buhagiar et al., 2011; Chwastiak, Rosenheck, Lewis, & Kazis, 2011; Farnam, Zipple, Tyrrell, & Chittinanda, 1999; Guzik & Wirshing, 2007; Hutchinson, 2005; Menza et al., 2004; Smith et al., 2007; ten Have, de Graaf, & Monshouwer, 2011; Vreeland et al., 2003.
6 studies did not include individuals with a diagnosis of SMI	Koivukangas et al., 2010; Kopp et al., 2011; Sagatun, Søgaard, Bjertness, Selmer, & Heyerdahl, 2007; Sanchez-Villegas et al., 2008; Str hle et al., 2007; Tyson, Wilson, Crone, Brailsford, & Laws, 2010
5 studies used qualitative methods for reporting results	Crone, 2007; Crone et al., 2004; Leutwyler & Wallhagen, 2010; McDevitt, Synder, Miller, & Wilbur, 2006; Tetlie, Heimsnes, & Almvik, 2009.
1 study did not use empirical research	Pack, 2009.

Note. Study denoted by first author.

considered in the results section. A table (Table 6) was used to summarize this.

Exploring Relationships

Techniques used to aid the interpretation of each of the stages included examination of each of the tables to consider what information was important to be summarized into paragraph form in the text. This was undertaken by two reviewers (AS/CR). The points made were examined and compared to consider how they grouped together. This stage was considered as conceptual mapping and triangulation and was selected to identify the salient points that needed to be discussed.

RESULTS

Forty one studies[1] were characterized into specific groups including, 5 studies that validated an SRQ, 1 study validated the RT3 triaxial accelerometer, 16 studies used an OBM to capture physical activity and 19 studies used an SRQ to capture physical activity. Based on the exclusion criteria 85 studies were not considered. Table 1 provides details of the included and excluded studies. The results are presented in accordance with each of the three techniques used within the methods: (1) the identification of the different outcome measures used; (2) the justification and choice of the different outcome measures used; and (3) the psychometric properties of outcome measures that have been validated in SMI populations.

The Identification of the Different Outcome Measures Used

The SRQs used by studies typically focused on recall of a seven-day period. Six tools were validated by studies that considered individuals with SMI. The tools with the long items were the Community Health Activities Model Program for Seniors (CHAMPS) (Stewart et al., 2001) and the health promoting lifestyle profile 2 questionnaire (Walker et al., 1995). The shortest tool was the Past Week Activity Questionnaire (PWA) (Ainsworth et al., 2000) outcome measure. The original validating articles consistently did not establish agreement between the outcome measure and a 'gold standard', therefore sole reliance on the original validating studies should not be considered. The Blair 7-day recall (7DR) (Blair, 1985) outcome measure was the most frequently (n = 5 studies) used. Table 2 provides full details of the SRQ used. The OBMs most commonly used included accelerometers. The RT3 was the accelerometer tool to be validated in individuals with SMI against doubly labeled water technique. The RT3 was the only tri-axial accelerometer used by previous studies, but other tri-axial accelerometers are available. Table 3 provides full details of the OBM used.

[1] This includes the duplication of studies across groups e.g., some studies measure physical activity more than one way.

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Table 2
A Descriptive Summary of Each of the Self-Reported Questionnaires (SRQ) Used by Research Considering Individuals with SMI.

Name of measure	Aims and scope of questionnaire	Recall period	Original validating article SMI studies that have validated the measure (SMI-VM)	Total no. of SMI studies using tool
The short version of the IPAQ	*Aim*: Designed for adults between the ages of 18–65. *Structure and Items*: Provides 7 questions. 6 questions focus on three types of activity (moderate, vigorous and walking) that establish the time spent in the last week and on average in that activity. The final question considers time spent sitting (sedentary behaviour)	7-day	*Original Validating Article:* Craig (2003) *General*: Study did not identify agreement between measures and did not use ICC for testing psychometric properties. *Test retest reliability*: Individual detail of coefficients were not given for test retest results but 75% of correlations were classified as moderate or above $\rho = 0.65$. *Criterion validity (CSA accelerometer):* identified a pool results of $\rho =$ 0.30 which achieved the level minimum association. *SMI-VM* – Faulkner et al. (2006)	1
CHAMPS	*Aim*: Designed to consider physical activities typically undertaken by older adults. *Structure and Item*: 41 items considering specific activities (including intensity of activity) which can be rated by frequency and duration.	4-week (considers typical week within previous 4 weeks)	*Original Validating Article*: Stewart et al. (2001) *General*: Research not compared against an OBM or gold standard measure. Recall assisted by; not requiring individuals to rate intensity (pg., 1127–1128). Possible burden: caused by length of questionnaire e.g., additional activities (not physical activities) are listed (pg., 1128). *Test retest reliability*: Each outcome identified moderate associations (r ranged between 0.60-0.67). *SMI-VM* –– Dubbert et al. (2006)	1
PWA	*Aim*: the questionnaire assesses occupational physical activity habit. *Structure and Items*: The past week activity focuses on three primary areas (1) time spent in non-occupational walking (moderate intensity), (2) moderate intensity recreational activities, (3) vigorous intensity recreational activities, and finally it also considered strength or toning activities	7-day	*Original Validating Article*: Ainsworth et al. (2000) General: Test-rest reliability not considered, ICC not considered and agreement between measures not provided. Some poor associations with criterion measures identified. *Criterion Validity (CSA accelerometer)*: Poor association on moderate physical activity output ($\rho = 0.04$). Minimum recommended correlation values were found for non occupational walking ($\rho =$ *0.28)* and hard/very hard activity ($\rho = 0.32$). *Criterion Validity (physical activity logs)*: Minimum recommended correlation was found between moderate physical activity ($\rho =$ 0.26). But not found for vigorous physical activity ($\rho = 0.09$). *SMI-VM* – Dubbert et al. (2006)	1
7DR	*Aim*: To measure habitual physical activity (leisure and occupational) in a free living population. *Structure and Items*: 4 main items are used. The first three items consider hours of employment and work. The fourth item has a work sheet where: (1) sleep per day is identified (2) physical activity split by category (moderate, hard, very hard) and time (morning afternoon evening) is identified. In addition to the minutes of aerobic physical activity, report of strength training and flexibility training each day can be given in a similar format (min/day).	7-day	*Original Validating Article*: Blair et al. (1985) General: Criterion validity does not consider agreement between measures or a OBM that has the same output. Test retest reliability is not provided. Output of 7DR limited to comparing energy expenditure. *Criterion Validity (miles run)*: minimum association achieved between total energy expenditure and total energy expenditure of hard and very hard activities r ranged between 0.21 – 0.45. The only criterion that did not reach the recommended level of association was the association between miles run at 3 months and energy expenditure of tool. *SMI-SV*– Ma et al. (2011) & Soundy (2007)	2
YPAS	*Aim*: to consider the type of activity that makes up an individual's regular routine. *Structure and Items*: 5 broad categories of activity are identified with the following number of items in each: work (n = 12 items), Yard work (n = 4 items), care taking (n = 2 items), Exercise (n = 6 items).	7-day	*Original Validating Article*: DiPietro, Caspersen, Ostfeld, and Nadel (1993) *General*: Agreement between was not identified or ICC were used for reliability. Levels of physical activity, minutes of activity are not provided by tool. *Test retest reliability*: achieved the minimum recommended effect size for leisurely walking (r = 0.48), moving (r = 0.49), standing (r = 0.48) and sitting (r = 0.42) indices and a moderate correlation for total time (r = 0.57), energy expenditure (r = 0.58), summary total (r = 0.65), and vigorous activity (r = 0.61). *Criterion validity (Vo2max):* the summary index (r = 0.58) and	1

(continued on next page)

Table 2 (*continued*)

Name of measure	Aims and scope of questionnaire	Recall period	Original validating article SMI studies that have validated the measure (SMI-VM)	Total no. of SMI studies using tool
			vigorous activity (r = 0.60) produced moderate associations. *SMI-VM* – Lindamer et al. (2008)	
The Health Promoting Lifestyle Profile 11	*Aim*: instrument is designed to measure and assess 6 different dimensions of health promotion and can assess determinants and patterns of lifestyle related to health. *Structure and Item*: 52 item questionnaire of which 7 items directly assess physical activity participation within specific statements where participants answer yes or no.	N/A –	*Original Validating Article*: Walker, Sechrist, and Pender (1995) *General*: Questionnaire misses some levels and types of physical activity and participants restricted to answering yes or no to items meaning quantification of physical activity levels is not possible. Most questions in scale that measures activity not related to physical activity level. ICC or agreement not considered. *Validity Factor Analysis:* factor loadings reported as good for exercise related tasks (stretching, vigorous exercise, supervised programs, recreation activity). *Variance explained by factor Eigen value 2.2.* *Test retest Reliability*: exercise dimension identified strong associations (r ranged between 0.81-0.93). *SMI-VM – None*	0
Godin Physical Activity Questionnaire	Aims to assess the reliability and concurrent validity of a simple questionnaire to assess leisure time physical activity.	7-day	*Original Validating Article*: Godin & Shephard (1997) *General*: No statistics to consider absolute agreement given. Criterion validity compared against fitness measure not considering the same output. *Test retest reliability*: achieved recommended minimum effect size for light (r = 0.48) and moderate activity (r = 0.46), moderate effect for total activity (r = 0.74) and strong effect for sweat (r = 0.80) and strenuous activity (r = 0.94). *Concurrent validity(Vo2max)*: did not achieve minimum effect size for moderate (r = 0.03) and light (r = 0.04) activity, but did for strenuous (r = 0.35) and total activity (r = 0.04). *SMI-VM – None*	
TAMII	*Aim*: to consider the total time spent at different activity levels over the last week, designed for a community dwelling sample of individuals who have coronary heart disease. *Structure and Items*: 6 questions, two questions are based around three intensity levels (strenuous, moderate and mild).These questions consider the frequency of exercise per week and the total time per week in each category.	7-day	*Original Validating Article*: Orrell, Doherty, Miles, Lewin, (2007) *General:* Agreement between accelerometer and TAM2 was not established. *Test retest reliability*: produced strong association for total activity (ICC = 0.82) and moderate activity (ICC = 0.85) but moderate for light activity (ICC = 0.54) and strenuous (ICC = 0.72) activity. *Criterion validity (TAM 1)*: considered over two time points for activity in MET mins and activity in minutes. For MET minutes light activity (T1: r = 0.17, T2: r = 0.02) on TAM2 and strenuous activity (T1: r = 0.04) on TAM 2 did not produce significant correlations. For activity minutes light activity at T2 produced a very low correlation (r = 0.03) and similar strenuous activity at T1 produced a low correlation (r = 0.04). Other correlations were above the minimum recommended effect size. *SMI-VM – None*	
AAS	*Aim*: to consider the physical activity components of individuals undertaking all forms of activity in the general population of Australia.	7-day	Original Validating Article: Armstrong, Bauman & Davies (2000) *Face Validity:* The survey was based on questions derived from three other national surveys and the influenced by the psychometric	

	Structure and Items: demographic information, 8 core questions assessing types of activity, 5 Likert questions assessing awareness of public health messages about physical activity.		properties reported by studies that have considered these instruments. *Test retest Reliability:* this was considered by Bull (2000) and ICC correlations were identified as between 0.6 to 0.8. *SMI-VM - None*	
3MPAC	3MPAC was developed for health care professionals to consider the type, level and frequency of physical activity for individuals in Taiwan who suffer from mental illness.	3-month	Original Validating Article: Ma et al. (2011) *General:* Internal consistency of scale does not use traditional statistical techniques to consider factors e.g., factor analysis or split half analysis. Rating for intensity of activities not against standards of previous identities (e.g., see Ainsworth et al., 2000). Reliability coefficient identified but type of correlation used was not identified e.g., spearman's or Pearson's. They state that ICC s are used to "evaluate agreement between the two scales "(pg., 1519) – citing Bland and Altman (2010) although do not consider limits of agreement between measures. Do not use OBM for criterion measure. *Internal consistency*: Items generated by focus groups and following content analysis. Items self rated for intensity, duration and frequency. Items assessed by experts familiar with "culture and mental health nursing" (pg., 1518) on a scale. Scale piloted on 30 adults with anxiety disorder and provides suggestions for each item in open ended responses. *Test retest reliability*: 30 adults with schizophrenia and 30 adults with anxiety disorder completed 3MPAC 2 weeks apart. Light activity reliability coefficient = 0.71, moderate activity ICC = 0.78, vigorous ICC = 0.86, identifying two moderate and one strong association. *Criterion validity*: validated against the Chinese version of the 7DR (Lu, Lin, Huang, Lee, & Wang, 2001). ICC for light activity achieved minimum association (ICC = 0.47). ICC for moderate activity (ICC = 0.64) and vigorous activity (ICC = 0.73) achieved moderate association. *SMI-VM* – Ma et al. (2011)	1

Note. Abbreviations for outcome measure are as follows: International Physical Activity Questionnaire (IPAQ), Community Health Activities Model Program for Seniors (CHAMPS), Past Week Activity Questionnaire (PWA), The Blair 7 day recall of Physical Activity Questionnaire (7DR), Yale Physical Activity Scale (YPAS), Total Activity Measure 2 (TAMII), Australia Active Scale (AAS), 3-Month Physical Activity Checklist (3MPAC).

Table 3
A Descriptive Summary of the Objective Based Measures (OBM) Used by Research Considering Individuals with SMI.

Name of measure	Technical detail of measure	Output of measure	Validating research and subsequent validation studies in SMI
RT3 (model T303, version 6.0, Professional Products, Reining, Madison, WI) accelerometer	*Type of Measure*: Tri-axial accelerometer, measuring movement in three planes; mediolateral (x), anteroposterior (y), and vertical (z) dimensions, as well as the vector magnitude (VM). *Mechanism*: piezo-electric accelerometer technology *Size*: 111 by 67 by 32 mm and weights 170 g. *Data Storage*: 21 days (maximum only collects a vector magnitude). *Attachment*: to participants' waist.	*Data Collected:* measures acceleration, which is converted into activity units, kcals and METs. Resting EE is calculated using regression equations based on gender, height, body mass and age as the independent variables (Pambianco, Wing, Robertson, 1990) and uses the same conversion from acceleration counts to EE as the Tritrac R3D.	*Initial Validation in Adults* - Eston (1998) *Subsequent Validation* - Sharpe et al. (2006a,b)
Doubly Labeled Water (DLW)	*Type of Measure*: direct method for measuring total energy expenditure over a set time period. *Measurement Period*: 10 day	*Data collected*: a calculation involving the use of racer isotopes is undertaken. Carbon dioxide and oxygen consumption are recorded and total energy expenditure is estimated.	*Initial validation in adults* - N/A Gold Standard Coward (1988) *Subsequent Validation* – N/A Gold Standard
CSA/Actigraphy Uniaxial accelerometer (model 7164, Computer Science and Applications, Inc., Shalimar, FL) also known as Actigraph	*Type of Measure*: Uniaxial accelerometer, measuring movement in the vertical plane. *Mechanism*: It measures acceleration (between 0.05–2.0 G) with a frequency response between 0.25–2.5 Hz. It uses a cantilevered beam with a mass attached to the unfixed end. *Size*: It is small (50 × 41 × 15 mm) and lightweight (43 g) *Data Storage*: 22 days. *Attachment*: It is worn on the wrist and uses an elastic belt to maintain positioning.	*Data collected*: The change in acceleration is sampled 10 times a second; these units are summed into epochs (user specified time period), where a typical duration is one minute.	*Initial Validation in Adults* Freedson, Melanson, Sirard (1998) *Subsequent Validation* – Lindamer et al. (2008)
SenseWearPro 2 (tm) from BodyMedia. Biaxial accelerometer	*Type of Measure*: Biaxial accelerometer, measuring movement in two planes vertical and horizontal *Mechanism*: measures acceleration with a RF frequency of 916.5 MHz. *Size*: 88 mm × 56 mm × 21 mm and light weight (52.2.4 g) *Data Storage*: 14 days *Attachment*: to the arm using a strap.	*Data Collected*: technical detail not available	*Initial Validation in Adults* - Jakicic et al. (2004) Subsequent validation for individuals with SMI -
Polar heart rate monitor from Polar Electro Oy, Finland.	*Type of Measure*: model not identified in paper. *Size*: Wrist watch and transmitter belt warn around the chest.	Data Collected: model not identified in paper.	*Initial Validation in Adults* - Laukkanen and Virtanen (1998) *Subsequent Validation*– None.

Note. Studies are denoted by first author.

Table 4
Criteria Considering How Studies Using Validated Self Report Questionnaires Have Justified Their Choice of Outcome Measure.

Justification of Measures Selected	*SRQ*	Choice of tool (a rationale to explain why this specific outcome measure was selected)	Original validation study cited?	Additional validation studies cited?	Technical or mathematical calculations undertaken in order to present the results within different intensities?	Reference to studies that provide details of how output is obtained?	Identification of values that represent different classification of types or intensities of physical activity?	Appropriateness considered (consideration of the suitability of the tool for the population group identified)	Total: (number/ 7)
Faulkner et al. (2006)	IPAQ	X	X	O	O	X	O	X	4
Dubbert et al. (2006)	CHAMPS	X	X	O	O	X	X	O	4
	PWA	X	X	X	O	X	X	O	5
Soundy (2007)	7DR	X	X	X	O	X	X	X	6
Archie et al. (2007)	Godin	O	X	O	O	O	O	O	1
Van Citters et al. (2010)	YPAS	O	X	O	O	X	O	O	2
Brown et al. (2006)	Lifestyle Profile II	O	X	O	X	X	O	O	3
Osborn et al. (2007)	Godin	O	X	X	O	X	O	O	3
Vancampfort et al. (2012)	IPAQ	X	X	X	O	X	O	O	4
Brown et al. (1999)	Godin	O	X	O	O	O	O	O	1
Brown et al. (2006)	Godin	O	X	O	O	O	O	O	1
Ellingrod et al. (2011)	TAMII	O	X	O	O	O	O	O	1
Lassenigus et al. (2013)	IPAQ	O	O	O	O	O	O	O	0
Ratliff et al. (2012)	Godin	O	X	O	O	O	O	O	1
Arbour et al. (2010)	IPAQ	O	X	O	O	O	X	O	2
Ussher et al. (2011)	7DR	O	X	O	O	X	O	O	2
Ussher (2003)	7DR	O	X	O	O	O	O	O	1
Lindamer et al. (2008)	YPAS	X	X	O	O	O	O	O	2
McLeod et al. (2009)	AAS	X	X	O	X	X	X	O	5
Ma et al. (2011)	7DR (Chinese version)	X	O	X	O	O	O	X	3
	3MPAC*	X	N/A	N/A	X	N/A	X	X	4/4

* Note. The 3MPAC is a validating study. Studies are denoted by the first author. Abbreviations for outcome measure are as follows: International Physical Activity Questionnaire (IPAQ), Community Health Activities Model Program for Seniors (CHAMPS), Past Week Activity Questionnaire (PWA), The Blair 7 day recall of Physical Activity Questionnaire (7DR), Yale Physical Activity Scale (YPAS), Total Activity Measure 2 (TAMII), Australia Active Scale (AAS), 3-Month Physical Activity Checklist (3MPAC), Godin leisure time questionnaire (Godin).

The Justification and Choice for the Different Outcome Measures Used

Each criterion within this section was summed to give a total out of 6.[2] Table 4 provides details of how authors justified their choice and use of an OBM. Table 5 provides details of how authors justified their choice of SRQ. Five studies using OBMs (Jerome et al., 2009; Sharpe et al., 2006a; Soundy et al., 2007; Wichniak et al., 2011; Yamamoto et al., 2011) scored a total of 5/6 or 6/6 against this criteria. The most consistent criterion missed by studies using OBMs was identification that the OMB had been calibrated by the researchers. The second most consistently missed criterion was a lack of reference to how or which mathematical calculations were undertaken to obtain results generated from the OBM. Finally, there was a high reliance of studies towards an original validating study, without further justification for the use of the outcome measure. Three studies using SRQs (Dubbert et al., 2006; Lindamer et al., 2008; Soundy et al., 2007) scored 5/6 or 6/6. Three main criteria were most often missed by studies that used SRQs, these were (a) the lack of consideration of the appropriateness of the measure selected; (b) the calculation for the output given; (c) additional validation studies were not considered or identified.

The Psychometric Properties of Outcome Measures that Have Been Validated in SMI populations

A detailed consideration was undertaken of the five articles that validated SRQs (Dubbert et al., 2006; Faulkner et al., 2006; Lindamer et al., 2008; Ma et al., 2011; Soundy et al., 2007) and one article that validated the RT3 accelerometer against doubly labeled water (Sharpe et al., 2006a). Two unpublished PhD thesis were accessed as part of this to allow further consideration of the research undertaken (Sharpe, 2007; Soundy, 2007). Table 6 provides full details of all the studies that have validated physical activity outcome measures in individuals with SMI. Using this table, a critique of each article is provided below:

The Yale Physical Activity Scale (YPAS) (DiPietro et al., 1993) was validated by Lindamer et al. (2008) and used the Actigraph accelerometer as the criterion measure. In summary, a small sample size was used for collecting the accelerometer data (n = 16) and no sample size calculation was identified. No measurement error or absolute agreement was considered. There was an absence of significant associations with a criterion measure. All but one of the test re-test associations only achieved a minimum recommended association. Given this, recommendations can't be made for using this tool solely based on this research.

The seven day recall of physical activity (7DR) (Blair, 1985) was examined by Soundy et al. (2007) and compared with an RT3 accelerometer as the criterion measure. In summary: vigorous activity only achieved a minimum recommended association for the test retest reliability. The minimum recommended association was not achieved for criterion validity of moderate or vigorous activity. The mean difference suggests the 7DR overestimates moderate physical activity and total energy expenditure and underestimates vigorous physical activity. The limits of agreement suggested that the 7DR is not suitable to consider individual levels of physical activity. Despite the correct use of statistical techniques the limited sample size (n = 14) needs to be considered when citing this as a validation study, identifying also that no sample size calculation was given. Researchers must be cautious about using this tool, adhering to the guidance of use provided within the article.

Both the CHAMPS (Stewart et al., 2001) and the past week physical activity questionnaire (PWA) (Ainsworth et al., 2000) were examined

[2] Where a study could not be assessed by an item the total score was reduced accordingly.

Table 5
Criteria Considering How Studies Using Objective Based Measurement Have Justified Their Choice of Outcome Measure.

Justification of measures selected	*Objective measure*	Choice of tool (identification of why this particular tool was chosen)	Identification of previous validation studies	Calculations for output given	Reference to studies that provide details of how output was obtained	Identification of values that represent different classification of types, intensities or volume of physical activity	Calibration/ Inter-monitor variability (for objective measures)	Total: (number/ 6)
Faulkner et al. (2006)	RT3	O	X	O	O	O	O	1
Sharpe et al. (2006a,b)	DLW	X	X	X	X	X	N/A	5
	RT3	X	X	X	X	X	X	6
Soundy (2007)	RT3	X	X	X	X	X	X	6
Dubbert et al. (2006)	RT3	X	X	O	X	O	O	3
Lindamer et al. (2008)	CSA accelerometer	X	X	X	X	X	O	5
Berle et al. (2010)	Actigraph (tm)	O	X	O	X	O	O	1
Farrow et al. (2005)	Actigraph (tm)	O	O	O	O	O	O	0
Gothelf et al. (2002)	CSA accelerometer	O	O	O	0	0	0	0
	Polar Hr monitor	O	O	0	0	0	0	0
Jerome et al. (2009)	RT3	X	X	X	X	X	O	5
Scheewe (2008)*	SenseWear (tm)	O	O	O	O	O	O	0
Wichniak et al. (2011)	Actigraph (tm)	O	O	O	O	O	O	0
Yamamoto et al. (2011)	RT3	X	X	X	X	X	O	5
McCormick et al. (2008)	MTI Accelerometer	O	X	O	X	X	O	3
Scheewe	SenseWear (tm)	O	O	O	O	O	O	0
McCormick et al. (2009)	MTI Accelerometer	X	X	N/A	O	O	O	2
McKibbin et al. (2006)	CSA accelerometer	O	O	O	O	O	O	0
Janney et al. (2008)	Actigraph (tm)	X	X	X	X	X	O	5

Note. Studies denoted by first author. CSA = Computer Science Application. DLW = Doubly labeled water. * = brief or short article.

by Dubbert et al. (2006) and compared against the RT3 accelerometer as the criterion measure. In summary, there was no consideration of ICC for reliability or assessment of measurement error or absolute agreement when considering criterion validity. In addition a small sample (n = 20) was used and no sample size calculation was given. Given this, recommendations for the use of this outcome measure in individuals with SMI can't be made.

The short form International Physical Activity Questionnaire (IPAQ) was examined by Faulkner et al. (2006) and compared this against the RT3 accelerometer as the criterion measure. In summary, criterion validity only reported minimum recommended associations between outcome measures. The association between measures could have used the same outcome units, but failed to. No measurement error or absolute difference was considered. An ICC was not used to assess reliability. A sample size larger than other studies was used, although no sample size calculation was given. Given this, recommendations for the use of this outcome measure in individuals with SMI can't be made.

The 3-month Physical Activity Checklist (3MPAC) was designed by Ma et al. (2011) and validated using the Chinese version of the 7DR (Lu et al., 2001) as the criterion measure. In summary, the development of the tool could have been strengthened. Reporting of reliability and validity is confusing. The criterion measure used is problematic. Caution is required when using this as a validation study. Given this, recommendations for the use of this outcome measure in individuals with SMI can't be made.

The RT3 accelerometer was validated by Sharpe et al. (2006a) by comparing this to doubly labeled water as the criterion measure. In summary, there was no significant association between activity energy expenditure measured by DLW and measures of activity using the RT3. Although there was a significant moderate association between in-activity measured by the RT3, a small sample size was used suggesting that the results need to be considered with caution. Further research is required to validate the RT3.

DISCUSSION

Without accurate measurement tools, research that considers physical activity patterns of individuals with SMI may suffer from misleading conclusions and inaccuracies. Researchers and clinicians have a duty to consider which outcome measure is used. A poor choice of measurement tool can remove the value of the data. The aim of this paper was to provide a greater understanding of the choice, use and psychometric properties of outcome measures currently used in individuals with SMI. This review has identified that whilst there is extensive research measuring and quantifying the levels of physical activity within individuals with SMI, there may be a lack of research that has considered and justified their choice challenging the validity and reliability of current findings. This review has identified significant limitations within the published literature in the choice and use of outcome measures of physical activity in studies of individuals with SMI. Awareness of this information is essential for researchers as well as clinicians when interpreting previous studies and when choosing which outcome measure to use in future studies or in clinical practice. Key problems with the application of physical activity outcome measures, which have emerged from the review, are

Please cite this article as: Soundy, A., et al., Selection, Use and Psychometric Properties of Physical Activity Measures to Assess Individuals with Severe Mental Illness: A Narra..., *Archives of Psychiatric Nursing* (2014), http://dx.doi.org/10.1016/j.apnu.2013.12.002

Table 6
A Summaries of the Studies That Validated Outcome Measures and the Consensus-Based Standards for the Selection of Health Measurement Instruments (COSMIN) Evaluation.

Author	Objectives or aims	Population (participants diagnoses, gender, age)	outcomes measures and analysis undertaken	Psychometric properties (CI; confidence interval)	COSMIN scores (Items that were poor or fair are reported to highlight methodological weakness)
Sharpe et al. (2006a)	Provide an assessment of the RT3 compared to doubly labeled water for estimating physical activity energy expenditure.	8 ♂ all diagnosed with paranoid schizophrenia	*Outcome measures* Doubly labeled water (DLW) technique using two stable isotopes (2H and 18O) RT3 accelerometer (Stay healthy Inc, Monrovia, CA) *Analysis* Pearson's Product moment correlation used and Bland & Altman (1986). T-Tests to compare difference in activity energy expenditure.	*Criterion validity* Correlations between activity energy expenditure (DLW) and RT3 output: VM (sum of vectors): r = 0.38, p = 0.35) Moderate physical activity (min/day): r = −0.28, p = 0.50 *Activity energy expenditure (kcal/day): r = 0.11, P = 0.80 Inactivity (% time): r = −0.83, p = 0.011. *T-test* Activity energy expenditure (t = −1.01, P = 0.34). *Mean Difference* RT3 over estimated activity energy expenditure 148 ± 413. *Limits of Agreement* Ranged from −661 to 958 kcal per day	*Test-retest reliability*: Three items on the checklist scored fair: Missing items of the tools are not identified. A small sample size is used. One item on the checklist scored poor: measurements were not independently taken. *Measurement error*: One item on the checklist scored fair: Missing items of the tools are not identified. Two items on the checklist scored poor: sample size was small and measurements were not independently taken. *Criterion validity*: One items on the check list scored fair: Missing items of the tools are not identified. One item on the check list scored poor: small sample size is used.
Faulkner et al. (2006)	Provide a study that validates the IPAQ. Reliability and validity of IPAQ compared to an RT3 accelerometer.	35 Outpatients based in Toronto, Canada. ♀:13 ♂:22 Age: 39.6 ± 10.7 Schizophrenia: 28 Schizophreniform: 1 Schizoaffective disorder: 6 Identified by interview (Sheehan et al., 1998). Diagnosis < 5 years: 12 >5 year: 23	*Outcome Measures* Short form International Physical Activity Questionnaire (IPAQ; Craig et al., 2003) RT3 accelerometer (Stay healthy Inc, Monrovia, CA) Both forms measured Total Minutes/week Total MET minutes/week IPAQ also measured Minutes of PA at different intensity levels; walking, moderate, vigorous *Analysis* Used Spearman's ρ for both test-retest reliability and criterion validity.	*Test-Retest Reliability* Spearman's ρ and CI: Total MET min week-1: ($\rho = 0.70$, $p < 0.01$)CI: 0.48-0.80 Total minutes of PA per week($\rho = 0.69$, $p < 0.01$) CI: 0.48-0.80 Vigorous physical activity($\rho = 0.69$, $p < 0.01$) CI: 0.46-0.83 Moderate physical activity ($\rho = 0.50$,$p < 0.01$)CI: 0.20-0.71 Walking ($\rho = 0.68$,$p < 0.01$)CI: 0.45-0.83 *Criterion Validity against RT3* Spearman's ρ and CI: Total minutes of PA compared ($\rho = 0.37$,$p < 0.05$) CI: 0.04 -0.63 Total IPAQ derived MET min/week ($\rho = 0.33$, $p > 0.05$)CI: 0.00-0.60	*Test-retest reliability*: Three items on the checklist scored fair: Missing items of the tools are not identified. A moderate sample size is used. A Pearson's correlation was used without evidence that no systematic changed had occurred. *Measurement error*: is not considered. *Criterion validity*: Two items on the check list score fair: Missing items of the tools are not identified. Moderate sample size is used. One item on the check list scored poor: comparisons were not made between the same outcome units when they could have been.
Dubbert et al. (2006)	"The primary aims of the study were therefore (1) to evaluate feasibility of using state-of-the-art physical activity assessment methods in SMI patients and (2) to explore relationship of physical activity to participants psychiatric symptoms" (pp. 206)	20 outpatients with a diagnosis of psychotic, mood or anxiety disorder with severe impairment in psycho-social functioning, as determined by a board-certified psychiatrist	*Outcome Measures* Community healthy activities model program for Seniors (CHAMPS; Stewart et al., 2001) Past Week Activity (PWA) interview (Ainsworth et al., 2000) RT3 accelerometer (StayHealthy, Inc., Monorvia, CA) *Analysis* Spearman's correlations were used for all associations	*Test Re-test Reliability* Sig. (p equal to or less than 0.1) greater reporting of activity at the first week. *Test re-test reliability* CHAMPS total kcal r = 0.84 CHAMPS frequency r = 0.89 PWA r = 0.68 time spent in moderate activity PWA r = 0.69 for moderate plus vigorous PWA r = 0.91 for total time spent walking per week *Inter-association between Questionnaires* CHAMPS total kcal was correlated with PWA walking minutes per week, $r_s = 0.77$, $p < 0.01$. CHAMPS exercise frequency score were also correlated with PWA moderate activity minutes per week, $r_s = 0.51$, $p = 0.02$ and with walking minutes per week $r_s = 0.55$, $p = 0.01$.	*Test retest reliability*: Three items on the check list scored fair: it is doubtful that the measurements taken were independent. A time interval for the test re test is not clearly stated. A Pearson's correlation was used without evidence that no systematic changed had occurred. One item on the checklist score poor: a small sample size of individuals with schizophrenia was used. *Measurement error*: not considered. *Criterion Validity*: One Item on the checklist scored fair: Missing items of the tools are not identified. One item on the check list score poor: the sample size for individuals with SMI.

(continued on next page)

Table 6 (*continued*)

Author	Objectives or aims	Population (participants diagnoses, gender, age)	outcomes measures and analysis undertaken	Psychometric properties (CI; confidence interval)	COSMIN scores (Items that were poor or fair are reported to highlight methodological weakness)
				Criterion Validity against RT3 Minutes of walking per week: CHAMPS $r_s = 0.4$, $p = 0.08$/PWA $r_s = 0.39$, $p = 0.03$ Kcal for moderate activity $r_s = 0.5$, $p = 0.03$	
Soundy (2007)	Examine the test retest reliability and the validity of the 7DR in a sample of individuals with SMI using RT3 accelerometers as the criterion measure.	14 Outpatients 52.9 ± 9.0 years. 10 = ♂ 4 = ♀ 9 = schizophrenia, 2 bi-polar, three manic depressive. Excluded: alcohol or drug abuse disorder and if could not give informed consent.	*Outcome Measures* The seven day recall of activity (7DR; Blair, 1985). RT3 accelerometer (StayHealthy, Inc., Monorvia, CA). *Analysis* Test re-test reliability was considered using ICC. Criterion validity was considered using Kendall's Tau and Bland and Altman's (1986) level of agreement.	*7DR Test Re-test Reliability* Single measures ICC TEE 0.98 ($f = 223.0$, $p < 0.01$, CI: $0.9 < u < 1.0$) Moderate activity: 0.60($f = 7.0$, $p < 0.01$, CI: $0.4 < u < 0.8$) Vigorous activity: 0.44($f = 4.2$, $p < 0.01$, $0.2 < u < 0.7$) *Criterion Validity* TEE $r_\tau = 0.43$, $p < 0.05$ *Mod. $r_\tau = 0.16$, $p > 0.05$ *Vig. $r_\tau = 0.08$, $p > 0.05$ *Mean Difference* TEE (kcal/day) 606.5 ± 605.5 (CI: $289.3 < u < 923.7$) Mod. (min/day) 16.9 ± 52.3 (CI: $8.0 < u < 25.7$) Vig. (min/day) -10.4 ± 24.3 (CI: $-7.6 < u < -13.18$) *Level of Agreement* TEE: Lower Limit = −604.5 Upper Limit: 1817.5 Mod: Lower Limit = −87.5 Upper Limit = 121.3 Vig: Lower limit = −58.9 Upper Limit = 38.1	*Test-retest reliability*: Three items on the checklist scored fair: Missing items of the tools are not identified. A small sample size is used. One item on the checklist scored poor: measurements were not independently taken. *Measurement error*: One item on the checklist scored fair: Missing items of the tools are not identified. Two items on the checklist scored poor: sample size was small and measurements were not independently taken. *Criterion validity*: One item on the check list scored fair: Missing items of the tools are not identified. One item on the check list scored poor: small sample size is used.
Lindamer et al. (2008)	3 fold: examine level of PA in individuals with schizophrenia compared to non psychiatric comparison; (2) establish test-rest reliability of YPAS in sample of individuals with schizophrenia; (3) assess the concurrent validity of YPAS.	54 outpatients based in California, USA. Age 50.7 ± 6.4 59.3% male Required to have a DSM-IV diagnosis of Schizophrenia or schizoaffective disorder.	Outcome measures Yale Physical Activity Scale (YPAS; DiPietro et al., 1993) Actigraph accelerometer (model 7164; formerly computer science applications) *Analysis* Pearson's r correlation was used for all associations.	*YPAS test re-test reliability* Time (h/week): $r = 0.6$, $p < 0.01$ Energy (kcal/week): $r = 0.6$, $p < 0.01$ Vigorous Activity Index: $r = 0.4$, $p < 0.01$ *Leisurely Walking Index: $r = 0.04$, $p > 0.05$ *Moving Index: $r = 0.10$, $p > 0.05$ Standing Index: $r = 0.34$, $p > 0.05$ Sitting Index: $r = 0.36$, $p > 0.05$ Total Activity Index: $r = 0.36$, $p > 0.05$ *YPAS criterion validity* *No significant associations between the YPAS and accelerometer were found in individuals with schizophrenia (no detail given): *YPAS Vig index and average daily mins of vigorous activity. *YPAS Vig index and Leisurely index score with moderate physical activity as measured by accelerometry identified. *YPAS moving index scores and average daily minutes of light activity measured by accelerometer. *YPAS standing and sitting indices and average minutes of sedentary activity measured by accelerometry.	*Test retest reliability*: Two items on the check list scored fair: it is doubtful that the measurements taken were independent. A Pearson's correlation was used without evidence that no systematic changed had occurred. One item on the checklist scored poor: a small sample size of individuals with schizophrenia was used. *Measurement error*: not considered. *Criterion Validity*: Two items on the check list scored poor: the sample size for individuals with schizophrenia. The correlations to demonstrate association between measures were not provided.

Ma et al. (2011)	Aims of the study were to establish the validity and reliability of a physical activity instrument for mental health professionals to identify levels, types and frequency of physical activity in Taiwanese individuals with mental illness.	100 individuals with different diagnosis were selected. No age or specific demographics provided. Within Questionnaire development 6 in patients with anxiety disorder and 4 in patients with schizophrenia were used. The questionnaire piloted on 30 Taiwanese in patients with anxiety disorder. Test retest reliability used another 30 in patients with anxiety disorder and 30 in patients with schizophrenia.	*Outcome Measures* 3-month physical activity checklist (3MPAC) Chinese version of the 7DR (Lu et al., 2001). *Analysis* Data was scored as light, moderate and vigorous activity. Test-retest reliability and criterion validity were analyzed using ICC.	*Internal consistency* Instrument and items of instrument designed using content analysis of two focus groups. Intensity of items were self rated using a 10 point scale (moderate = 5–6, vigorous = 7–8 no further detail given see page 1518). Suitability of items rated by "*experts familiar with Taiwanese culture and mental health nursing assess suitability of all 3MPAC items using 4-point scale from 1 (very inappropriate) to 4 (very appropriate). All items were acceptable, having an average score of >3*" (Pg., 1518). However, a mean should not be used in this context. Within a pilot study 30 individuals with Anxiety disorder who could write comments next to each item. *Test retest reliability* Light activity ICC = 0.71 Moderate activity ICC = 0.78 Vigorous activity ICC = 0.86. *Criterion Validity (compared with 7DR)* Light activity ICC = 0.47, $p < 0.0001$, 95% CI = 0.34-0.59 Moderate activity ICC = 0.64, $p < 0.0001$, 95% CI = 0.51-0.74 Vigorous activity ICC = 0.73, $P < 0.0001$, 95% CI = 0.62-0.80	*Content Validity*: Three items on the checklist score poor: the initial focus groups could have included other groups e.g., health professionals to compliment the item generation. Reference to a compendium of activities to consider saturation of activities and in order to rate intensity of activity could have been used. Rationale for 3 month duration is required, especially considering the identification of problems with recall of activity. *Test-Retest Reliability*: Five items on the checklist scored fair: Missing items of the tools are not identified. It was not reported if the administration of the test was independent. It was not considered if the patients were stable in their health condition. Details for both test conditions were not identified. The ICC may have been calculated for reliability, if it has been it has not been reported fully. *Criterion Validity*: Two items on the check list scored fair: If any items of the tools were missing is not identified. Correlations between measures are represented by ICC. One item on the check list scored poor: Criterion used cannot be considered an adequate 'gold standard'. *Measurement Error*: Three items on the checklist scored fair: If any items of the tools were missing is not identified. It was not reported if the administration of the test was independent. It was not considered if the patients were stable in their health condition. Two factors score poor: No Bland and Altman (2010) level of agreement is reported, despite identifying one. The use of the symbol 'r' is questionable when reporting ICC.

Note. Studies denoted by first author. * represents association that did not meet the minimum strength of association.

highlighted below, followed by recommendations of how to approach physical activity measurement in the future.

The Problems Regarding the Justification of Outcome Measure within Previous Literature

Authors must be more rigorous in their choice of outcome measures. One major problem of studies measuring physical activity is the failure of researchers to consider or justify why they have chosen a particular OBM or SRQ. For example past research studies (Archie et al., 2007; Brill et al., 2007; Buhagiar et al., 2011; Chuang et al., 2008; Crone et al., 2004; Daumit et al., 2005; Davidson et al., 1999; Davidson et al., 2001; Ellingrod et al., 2011; Elmslie et al., 2001; Farnam et al., 1999; Lassenigus et al., 2013; McCreadie, 2003; Osborn et al., 2007; Ratliff et al., 2012; Samele et al., 2007; SØrensen, 2006; Van Citters et al., 2010; Vancampfort et al., 2011a,b,c; Vancampfort et al. (2011d) have utilised a specific SRQ and justified its choice solely on the original study which validated the SRQ. This is often problematic if the tool has been validated in a certain population or if the original study was not validated correctly. Agreement between measures must be considered in future research (Bland & Altman, 2010; Warren et al., 2010). A major problem in the validating process of studies was that agreement was most often not considered. In addition to this, small sample sizes were used in 4/5 validating studies. In future research, the choice of sample size requires careful consideration with reference to research that establishes this e.g., Walter, Eliaszi, and Donner (1998).

In summary, a standard reporting protocol for the method sections of future papers may be based on the criteria given within Tables 3–4. It is important to note that there are a number of studies that provide greater justification for their choice of their outcome measure; these higher scoring studies may be an initial way to locate a physical activity outcome measure to use.

In a similar way, only two studies using OBMs in the present review referenced their calibration protocol. This is important because calibration protocols can create errors in the outcomes of OBMs (Prince et al., 2008). Acknowledging and being transparent about the calibration process will enable readers to be assured that the monitors are functioning correctly and able to detect changes in activities.

Factors that Influence the Measurement of Physical Activity

Several factors may influence the measurement of physical activity by SRQs: (a) Much of the activity documented may be unstructured and of low intensity, meaning the SRQs may not capture the activity. (b) Individuals with SMI may have a shorter attention span and errors in comprehension, information retrieval and reporting. Problems including recall and response bias are identified in previous research (Prince et al., 2008). (c) The SRQ may be limited through its use of questioning e.g., they may require recall of information over a long period of time, rather than considering specific times of day (Shephard, 2003) or they may be limited by their use of questioning e.g., not using categories of physical activity or interval responses e.g., 1–2 hours, 2–3 hours (Sarkin, Nichols, Sallis, & Calfas, 2000). (d) Some SRQs will establish energy expenditure, although this measurement may be significantly influenced by the weight of the individual, because of the calculations used to estimate it. (e) Whilst at a sample level SRQs may represent levels of physical activity, the ability to accurately estimate individual levels of physical activity may be problematic.

What Outcome Measure Should be Chosen for Use?

Within this section we first consider SRQs then consider OBMs. To the best of the authors' knowledge, only five research studies have attempted to validate SRQs when considering individuals with SMI. The most frequent validation tools were accelerometers, a finding reported in another research (Prince et al., 2008), which were combined with a limited selection of SRQs. The present review highlighted methodological weaknesses of these studies. Specifically the main and recurrent problems included (1) inadequate consideration of measurement error, in that whilst the SRQ may be associated with the OBM, it may not be accurately reflecting the volume of activity undertaken; (2) the absence in using inter class correlation coefficient when considering test retest reliability which essentially is recognized as the statistical method of choice for such reliability measures (3) a lack of sample sizes that were selected based on a power calculation, a requirement made possible by previous literature e.g., (Walter et al., 1998). Further, inconsistency in validation studies has been reported by other literature and is not unusual (Forsen et al., 2010). Given this information as a whole, we would suggest it is the responsibility of an individual who selects an SRQ to understand the weakness in the validation studies before the tool is utilised. Within the current study the SRQ which has been validated with least problems is the 7DR, however, the validation study (Soundy et al., 2007) had a small sample size and the paper itself cautions against using the questionnaire for intervention work. Further research is required if the utilization of different outcome measures are to be considered.

The use of OBMs is likely associated with less error in the estimation of physical activity and may be the preferred option (costs and time permitting). Accelerometers (notably the RT3) have been used as the criterion measure, despite the caution of their use and accuracy in determining activity energy expenditure (Sharpe et al., 2006a) and errors generated by equations used to categorize and define physical activity in OBM (Prince et al., 2008). The RT3 is suggested to be an appropriate criterion measure (Eston, Rowlands, & Ingledew, 1998; Powell & Rowlands, 2004; Powell et al., 2003) and sensitive in capturing and distinguishing time spent at different intensities of physical activity (Soundy et al., 2007; Yamamoto et al., 2011).

The Robustness of the Synthesis and Limitations of the Review

The narrative synthesis appears to have been able to address the original aims and the different procedures were able to identify some essential problems in the literature. There are however several limitations of this synthesis: (1) the synthesis was only able to focus on a small aspect of each study and did not take consideration of articles that may have been restricted by word limits; (2) the review limited the consideration to specific outcome measures and there may be other recent outcome measures (SRWs or OBMs) meriting further consideration.

Further Consideration of the validated SRQs

It is essential that researchers and clinicians are able to accurately understand the level of physical activity of individuals with SMI. If the SRQs have not been validated correctly then the current understanding of the levels of physical activity may be impacted. Thus, our current understanding of physical activity in individuals with SMI will be challenged.

CONCLUSION

A great deal of research that uses SRQs and OBMs to capture physical activity in individuals with SMI does not consider the use, value, or shortcomings the outcome measure selected. The current results suggest that there is a real need to consider why particular SRQ or OBM should be used for capturing physical activity in individuals with SMI and also identifies that clinicians and researchers need to be aware of previous validation processes that have been conducted to support the use of a particular outcome measure.

Please cite this article as: Soundy, A., et al., Selection, Use and Psychometric Properties of Physical Activity Measures to Assess Individuals with Severe Mental Illness: A Narra..., *Archives of Psychiatric Nursing* (2014), http://dx.doi.org/10.1016/j.apnu.2013.12.002

FUNDING BODY AGREEMENTS AND POLICIES

No funding was obtained for this research.

Acknowledgment

No acknowledgements are required for this piece of research.

References

Acil, A. A., Dogan, S., & Dogan, O. (2008). The effects of physical exercises to mental state and quality of life in patients with schizophrenia. *Journal of Psychiatric and Mental Health Nursing*, *15*, 808–815.

Adams, L. (1995). How exercise can help people with mental health problems. *Nursing Times*, *91*, 37–39.

Ainsworth, B. E., Bassett, D. R., Scott, S. J., Swatz, A. M., O'Brien, W. L., Thompson, R. W., et al. (2000). Comparison of three method for measuring the time spent in physical activity. *Medicine and Science in Sports and Exercise*, *332*, S457–S464.

Aquila, R. E. M. (2000). Interventions for weight gain in adults treated with novel antipsychotics. *The Primary Care Companion to The Journal of Clinical Psychiatry*, *2*, 20–23.

Arango, C., Bobes, J., Aranda, P., Carmena, R., Garcia-Garcia, M., & Rejas, J. (2008). A comparison of schizophrenia outpatients treated with antipsychotics with and without the metabolic syndrome: findings from the CLAMORS study. *Schizophrenia Research*, *104*, 1–12.

Arbour, K. P., Faulkner, G. E., & Cohn, T. A. (2010). Body image in individuals with schizophrenia: examination of the B-WISE (r) questionnaire. *Schizophrenia Research*, *118*, 307–308.

Archie, S. M., Goldberg, J. O., Akhtar-Danesh, N., Landeen, J., McColl, L., & McNiven, J. (2007). Psychotic disorders, eating habits, and physical activity: who is ready for lifestyle changes? *Psychiatric Services*, *58*, 233–239.

Archie, S. M., Wilson, J. H., Osborne, S., Hobbs, H., & McNiven, J. (2003). Pilot study: access to fitness facility and exercise levels in olanzapine-treated patients. *Canadian Jorunal of Psychiatry*, *48*, 628–632.

Armstrong, N., & Welsman, J. R. (2006). The physical activity patterns of European youth with reference to methods of assessment. *Sports Medicine*, *36*, 1067–1086.

Armstrong, T., Bauman, A., & Davies, J. (2000). *Physical activity patterns of Australian adults. Results of the 1999 national physical activity survey*. Canberra: Australian Institute of Health and Welfare.

Ball, M. P., Coons, V. B., & Buchanan, R. W. (2001). A program for treating olanzapine-related weight gain. *Psychiatric Services*, *52*, 967–969.

Barton, J., Griffin, M., & Pretty, J. (2012). Exercise-, nature- and socially interactive-based initiatives improve mood and self-esteem in the clinical population. *Perspectives in Public Health*, *132*, 89–96.

Beebe, L. H., & Harris, R. F. (2012). Using pedometers to document physical activity in patients with schizophrenia spectrum disorders. *Journal of Psychosocial Nursing*, *50*, 44–49.

Beebe, L. H., Tian, L., Morris, N., Goodwin, A., Swant, S., & Kuldau, J. (2005). Effects of exercise on metal and physical parameters of persons with schizophrenia. *Issues in Mental Health Nursing*, *26*, 661–676.

Berle, O. J., Hauge, E. R., Oedegaard, K. J., Holsten, F., & Fasmer, O. B. (2010). Actigraphic registration of motor activity reveal a more structured behavioural pattern in schizophrenia than in major depression. *BMC Research Notes*, *3*, 149.

Blair, S. N. (Ed.). (1985). *How to assess exercise habits and physical fitness*. New York: John Wiley & Sons.

Blair, S. N., Haskell, W. L., Ho, P., Paffenbarger, R. S., Jr., Vranizan, K. M., Farquhar, J. W., et al. (1985). Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *American Journal of Epidemiology*, *122*, 749–804.

Bland, J. M., & Altman, D. G. (1986). Statistical-methods for assessing agreement between 2 methods of clinical measurement. *Lancet*, *1*(8476), 307–310.

Bland, J. M., & Altman, D. G. (1999). Measuring agreement in method comparison studies. *Statistical Methods in Medical Research*, *8*, 135–160.

Bland, J. M., & Altman, D. G. (2010). Statistical methods for assessing agreement between two method of clinical measurement. *International Journal of Nursing Studies*, *47*, 931–936.

Bobes, J., Alegría, A. A., Saiz-Gonzalez, M. D., Barber, I., Pērez, J. I., & Saiz-Ruiz, J. (2010a). Change in psychiatrists' attitudes towards the physical health care of patients with schizophrenia coinciding with the dissemination of the consensus on physical health in patients with schizophrenia. *European Psychiatry*, *26*, 305–312.

Bobes, J., Arango, C., Garcia-Garcia, M., & Rejas, J. (2010b). Healthy lifestyle habits and 10-year cardiovascular risk in schizophrenia spectrum disorders: An analysis of the impact of smoking tobacco in the CLAMORS schizophrenia cohort. *Schizophrenia Research*, *119*, 101–109.

Brill, N., Reichenberg, A., Rabinowitz, J., Harary, E., Lubin, G., Davidson, M., et al. (2007). Accuracy of self-reported premorbid functioning in schizophrenia. *Schizophrenia Research*, *97*, 103–108.

Brown, S., Birtwistle, J., Roe, L., & Thompson, C. (1999). The unhealthy lifestyle of people with schizophrenia. *Psychological Medicine*, *29*, 697–701.

Brown, C., Goetz, J., Van Sciver, A., Sullivan, D., & Hamera, E. (2006). A psychiatric rehabilitation approach to weight loss. *Psychiatric Rehabilitation Journal*, *29*, 267–273.

Brunero, S., & Lamont, S. (2010). Health behavior beliefs and physical health risk factors for cardiovascular disease in an outpatient sample of consumers with a severe mental illness: A cross sectional survey. *International Journal of Nursing Studies*, *47*, 753–760.

Buhagiar, K., Parsonage, L., & Osborn, D. P. J. (2011). Physical health behaviors and health local of control in people with schizophrenia-spectrum disorder and bipolar disorder: A cross-sectional comparative study with people with non-psychotic mental illness. *BMC Psychiatry*, *11*, 104.

Bull, F. C. (2000). The reliability and validity of recall of moderate-intensity physical activity Unpublished report to DHAC.

Center for Reviews, Dissemination (CRD). (2009). *Systematic reviews: CRD's guidance for undertaking reviews in healthcare* (3rd ed): University of York: York Publishing Services Ltd.

Centorrino, F., Wurtman, J. J., Duca, K. A., Fellman, V. H., Fogarty, K. V., Berry, J. M., et al. (2006). Weight loss in overweight patients maintained atypical antipsychotic agents. *International Journal of Obesity*, *30*, 1011–1016.

Charmove, A. S. (1986). Exercise improves behaviour: a rationale for occupational therapy. *British Journal of Occupational Therapy*, *49*, 83–86.

Chuang, H. T., Mansell, C., & Pattern, S. (2008). Lifestyle characteristics of psychiatric outpatients. *La Revue Canadienne de Psychiatrie*, *53*, 260–266.

Chwastiak, L. A., Rosenheck, R. A., Lewis, E., & Kazis, L. E. (2011). Association of psychiatric illness and obesity, physical inactivity and smoking among a national sample of veterans. *Psychosomatics*, *52*, 230–236.

Cohen, A., Singh, S. P., & Hague, J. (2004). *The primary care guide to managing severe mental illness*. London: The Sainsbury Centre for Mental Health, 1–24.

Coward, W. A. (1988). Stable isotopic methods for measuring energy expenditure. The doubly-labelled-water (2H2(18O) method: principles and practice. *The Proceedings of the Nutrition Society*, *47*, 209–218.

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., et al. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*, 1381–1395.

Crone, D. (2007). Walking back to health: a qualitative investigation into service users; experiences of a walking project. *Issues in Mental Health Nursing*, *28*, 167–183.

Crone, D., Heaney, L., Herbert, R., Morgan, J., Johnston, L., & Macpherson, R. (2004). A comparison of lifestyle behaviour and health perceptions of people with severe mental illness and the general population. *Journal of Public Mental Health*, *3*, 19–25.

Daumit, G. L., Goldberg, R. W., Anthony, C., Dickerson, F., Brown, C. H., Kreyenbuhl, J., et al. (2005). Physical activity patterns in adults with severe mental illness. *Journal of Nervous and Mental Disorders*, *193*, 641–646.

Davidson, S., Judd, F., Jolley, D., Hocking, B., Thompson, S., & Hyland, B. (2001). Cardiovascular risk factors for people with mental illness. *Australian and New Zealand Journal of Psychiatry*, *35*, 196–202.

Davidson, M., Reichenberg, A., Rabinowitz, J., Weiser, M., Kaplan, Z., & Mark, M. (1999). Behavioural and intellectual markers for schizophrenia in apparently healthy male adolescents. *American Journal of Psychiatry*, *156*, 1328–1335.

Department of Health. (1995). *Building Bridges: a guide to arrangements for inter-agency working for the care and protection of severely mentally ill people*. London, UK: Department of Health.

Department of Health and Human Services (1999). *Mental health: A report of the surgeon general – executive summary*. Rockville, MD: U.S.A. Department of Health and Human Services.

DiPietro, L., Caspersen, C. J., Ostfeld, A. M., & Nadel, E. R. (1993). A survey for assessing physical activity among older adults. *Medicine and Science in Sport and Exercise*, *25*, 628–642.

Dodd, K. J., Duffy, S., Stweart, J. A., Impey, J., & Taylor, N. (2011). A small group aerobic exercise programme that reduces body weight is feasible in adults with severe chronic schizophrenia: a pilot study. *Disability and Rehabilitation*, *33*, 1222–1229.

Dubbert, P. M., White, J. D., Grothe, K. B., O'Jile, J., & Kirchner, K. A. (2006). Physical activity in patients who are severely mentally ill: feasibility of assessment for clinical and research applications. *Achieves of Psychiatric Nursing*, *20*, 205–509.

Duraiswamy, G., Thirthalli, J., Nagendra, H. R., & Gangadhar, B. N. (2007). Yoga therapy as an add-on treatment in the management of patients with schizophrenia – a randomised controlled trial. *Acta Psychiatrica Scaniavica*, *116*, 226–232.

Ellingrod, V. L., Taylor, S. F., Brook, R. D., Evans, S. J., ZÖllner, S. K., Grove, T. B., et al. (2011). Dietary, lifestyle and pharmacogenetic factors associated with arteriole endothelial-dependent vasodilatation in schizophrenia patients treated with atypical antipsychotics (AAPs). *Schizophrenia Research*, *130*, 20–26.

Elmslie, J. L., Mann, J. I., Silverstone, J. T., Williams, S. M., & Romans, S. E. (2001). Determinants of overweight and obesity in patients with bipolar disorder. *Journal of Clinical Psychiatry*, *62*, 486–491.

Eston, R. G., Rowlands, A. V., & Ingledew, D. K. (1998). Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities. *Journal Applied Physiology*, *84*, 362–371.

Farnam, C. R., Zipple, A. M., Tyrrell, W., & Chittinanda, P. (1999). Health status and risk factors of people with severe and persistent mental illness. *Journal of Psychosocial Nursing & Mental Health Services*, *37*, 16–21.

Farrow, T. F. D., Hunter, M. D., Haque, R., & Spence, S. A. (2006). Modafinil and unconstrained motor activity in schizophrenia. *British Journal of Psychiatry*, *189*, 461–462.

Farrow, T. F. D., Hunter, M. D., Wilikinson, I. D., Green, R. D. J., & Spence, S. A. (2005). Structural brain correlates of unconstrained motor activity in people with schizophrenia. *British Journal of Psychiatry*, *187*, 481–482.

Faulkner, G., Cohn, T., & Reminghton, G. (2006). Validation of a physical activity assessment tool for individuals with schizophrenia. *Schizophrenia Research*, *82*, 225–231.

Faulkner, G., Taylor, A., Munro, S., Selby, P., & Gee, C. (2007). The acceptability of physical activity programming within a smoking cessation service for individuals with severe mental illness. *Patient Education and Counseling*, *66*, 123–126.

Please cite this article as: Soundy, A., et al., Selection, Use and Psychometric Properties of Physical Activity Measures to Assess Individuals with Severe Mental Illness: A Narra..., *Archives of Psychiatric Nursing* (2014), http://dx.doi.org/10.1016/j.apnu.2013.12.002

Fogarty, M., Happell, B., & Pinikahana, J. (2004). The benefits of an exercise program for people with schizophrenia: a pilot study. *Psychiatric Rehabilitation Journal*, *28*, 173–178.

Forsen, L. L. N., Vuillemin, A., Chinapaw, M. J. M., van Poppel, M. N. M., Mokkink, L. B., van Mechelen, W., et al. (2010). Self-administered physical activity questionnaires. *Sports Medicine*, *40*, 601–623.

Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the computer science and applications, Inc. accelerometer. *Medicine and Science in Sport and Exercise*, *30*, 777–781.

Gimino, F. A., & Levin, S. J. (1984). The effects of aerobic exercise on perceived self-image in post hopstialised schizophrenic patients. *Medicine and Science in Sports and Exercise*, *16*, 139.

Godin, G., & Shephard, R. J. (1997). Godin Leisure-Time Exercise Questionnaire. *Medicine and Science in Sports and Exercise*, *29*(June Supplement), S36–S38.

Gorczynski, P., & Faulkner, G. (2011). Exercise therapy for schizophrenia. *Cochrane Database of Systematic Reviews*, *5*, CD004412, http://dx.doi.org/10.1002/14651858.CD004412.pub2.

Gothelf, D., Falk, B., Singer, P., Kairi, M., Phillip, M., Zigel, L., et al. (2002). Weight gain associated with increased food intake and low habitual activity levels in male adolescent schizophrenic inpatients treated with olanzapine. *American Journal of Psychiatry*, *159*, 1055–1057.

Guzik, L. H., & Wirshing, D. A. (2007). Behavioural weight loss classes for patients with severe mental illness. *Psychiatric Services*, *58*, 1498.

Harmatz, M. G. L. P. (1968). Behavior modification of overeating in a psychiatric population. *Journal of Consultant Clinical Psychology*, *32*, 583–587.

Hauge, E. R., Berle, O. J., Oedegaard, K. L., Holsten, F., & Fasmer, O. B. (2011). Nonlinear analysis of motor activity shows differences between schizophrenia and depression: A study using Fourier analysis and sample entropy. *Plos One*, *6*, 1–10.

Heimberg, C., Gallacher, F., Gur, R. C., & Gur, R. E. (1995). Diet and gender moderate clozapine-related weight-gain. *Human Psychopharmacology-Clinical and Experimental*, *10*, 367–371.

Hendryx, M., Green, C. A., & Perrin, N. A. (2009). Social support, activities and recovery from serious mental illness: STARS study findings. *The Journal of Behavioural Health services and Research*, *36*, 320–329.

Hutchinson, D. S. (2005). Structured exercise for persons with serious psychiatric disabilities. *Psychiatric Services*, *56*, 353–354.

Hutchinson, D. S., Skrinar, G. S., & Cross, C. (1999). The role of improved physical fitness in rehabilitation and recovery. *Psychiatric Rehabilitation Journal*, *22*, 355–359.

Jakicic, J. M., Marcus, M., Gallagher, K. I., Randall, C., Thomas, E., Goss, F. L., et al. (2004). Evaluation of the sensewear pro armband to assess energy expenditure during exercise. *Medicine and Science in Sports and Exercise*, *36*, 897–904.

Janney, C. A. (2012). *Physical activity in overweight and obese adults with schizophrenia and schizoaffective disorders* ((Ph.D), Pittsburgh, Pittsburgh).

Janney, C. A., Richardson, C. R., Holleman, R. G., Glasheen, C., Strath, S. J., Contry, M. B., et al. (2008). Gender, mental health service use and objectively measured physical activity: data from the national health and nutrition examination survey (NHANES 2003–2004). *Mental Health and Physical Activity*, *1*, 9–16.

Jerome, G. J., Young, D. R., Dalcin, A., Charleston, J., Anthony, C., Hayes, J., et al. (2009). Physical activity levels of persons with mental illness attending psychiatric rehabilitation programs. *Schizophrenia Research*, *108*, 252–257.

Joukamaa, M., Heliövaara, M., Knekt, P., Aromaa, A., Raitasalo, R., & Lehtinen, V. (2006). Schizophrenia, neuroleptic medication and mortality. *British Journal of Psychiatry*, *188*, 122–127.

Kane, I., Lee, H., Sereika, S., & Brar, J. (2012). Feasibility of pedometers for adults with schizophrenia: pilot study. *Journal of Psychiatric and Mental Health Nursing*, *19*, 8–14.

Klein, B., Steele, R. I., Simon, W. E., & Primavera, L. H. (1972). Reinforcement and weight loss in schizophrenics. *Psychological Reports*, *30*, 581–582.

Koivukangas, J., Tammelin, T., Kaakinen, M., Mäki, P., Moilanen, I., Taanila, A., et al. (2010). Physical activity and fitness in adolescents at risk for psychosis within northern Finland 1986 birth cohort. *Schizophrenia Research*, *116*, 152–158.

Kopp, M., Fleischhacker, W. W., StÜrz, K., Ruedl, G., Kumnig, M., & Rumpold, G. (2011). Poor health behavior and reduced quality of life of people treated with psychotropic drugs. *Human Psychopharmacology-Clinical and Experimental*, *26*, 161–167.

Lassenigus, O., kerlind, I., Wiklund-Gustin, L., Arman, M., & Söderlund, A. (2013). Self-reported health and physical activity among community mental health users. *Journal of Psychitric and Mental Health Nursing*, *20*, 82–90, http://dx.doi.org/10.1111/j.1365-2850.2012.01951.x.

Laukkanen, R. M., & Virtanen, P. K. (1998). Heart rate montiors: state of the art. *Journal of Sport Science*, *16*(suppl), S3–S7.

Lempp, H., Thornicroft, G., Leese, M., Fearns, N., Graves, H., Khoshaba, B., et al. (2009). Implications of long-term conditions for both mental and physical health: a comparison of rheumatoid arthritis and schizophrenia. *Quality of Life Research*, *18*, 699–707.

Leutwyler, H. C., & Wallhagen, M. I. (2010). Understanding physical health of older adults with schizophrenia: building and eroding trust. *Journal of Gerontological Nursing*, *36*(5), 38–45.

Lindamer, L. A., McKibbin, C., Norman, G. J., Jordan, L., Harrison, K., Abeyesinhe, S., et al. (2008). Assessment of physical activity in middle aged and older adults with schizophrenia. *Schizophrenia Research*, *104*, 294–301.

Lu, C. M., Lin, S. L., Huang, Y. C., Lee, M. H., & Wang, S. F. (2001). A study on validity and reliability of self-report measures of physical activityusing TriTrac-R3D accelerometer as criterion. *Journal of Health Promotion and Health Education*, *15*, 99–114 (in Chinese with English abstract).

Ma, W. -F., Chiang, L. -C., Yen, W. -J., Huang, L. -C., & Tsai, T. -W. (2011). Three-month physical activity checklist: development and validation with Taiwanese adults with mental illness. *International Journal of Nursing Studies*, *48*, 1517–1521.

Martin-Sierra, A., Vancampfort, D., Probst, M., Bobes, J., Maurissen, K., Sweers, K., et al. (2011). Walking capacity is associated with health related quality of life and physical activity level in patients with schizophrenia: a preliminary report. *Actas Españolas Psiquiatria*, *39*, 211–216.

McCormick, B. P., Frey, G. C., Lee, C. -T., Chun, S., Sibthorp, J., Gajic, T., et al. (2008). Predicted transitory mood from physical activity level among people with severe mental illness in two cultures. *International Journal of Social Psychiatry*, *54*, 527–538.

McCormick, B. P., Frey, G. C., Lee, C. T., Gajic, T., Stamatovic-Gajic, B., & Maksimovic, M. (2009). A pilot examination of social context and everyday physical activity among adults receiving Community Mental Health Services. *Acta Psychiatrica Scandinavica*, *119*(3), 243–247.

McCreadie, R. G. (2003). Diet, smoking and cardiovascular risk in people with schizophrenia. *British Journal of Psychiatry*, *203*, 534–539.

McDevitt, J. (2005). A group-based walking program at a psychiatric rehabilitation centre. *Psychiatric Services*, *56*, 354–355.

McDevitt, J., Synder, M., Miller, A., & Wilbur, J. (2006). Perception of barriers and benefits to physical activity among outpatients in psychiatric rehabilitation. *Journal of Nursing Scholarship*, *38*, 50–55.

McDevitt, J., Wibur, J., Kogan, J., & Briller, J. (2005). A walking program for outpatients in psychiatric rehabilitation: a pilot study. *Biological Research for Nursing*, *7*, 87–97.

McGale, N., McArdle, S., & Gaffney, P. (2010). Exploring the effectiveness of an integrated exercise/CBT intervention for young men's mental health. *British Journal of Health Psychology*, *16*, 457–471.

McKay, C. E., & Pelletier, J. R. (2007). Health promotion in clubhouse programs: needs, barriers, and current and planned activities. *Psychiatric Rehabilitation Journal*, *31*, 155–159.

McKibbin, C. L., Patterson, T. L., Norman, G., Patrick, K., Jin, H., Roesch, S., et al. (2006). A lifestyle intervention for older schizophrenia patients with diabetes mellitus: A randomised controlled trial. *Schizophrenia Research*, *86*, 36–44.

McLeod, H. J., Jaques, S., & Deane, F. P. (2009). Base rates of physical activity in Australians with schizophrenia. *Psychiatric Rehabilitation Journal*, *32*, 261–267.

Menza, M., Vreeland, B., Minsky, S., Gara, M., Radler, D. R., & Sakwitz, M. (2004). Managing atypical antipsychotic-associated weight gain: 12-month data on a multimodal weight control program. *Journal of Clinical Psychiatry*, *65*, 471–477.

Methapatara, W., & Srisurapanont, M. (2011). Pedometer walking plus motivational interviewing program for Thai schizophrenic patients with obesity or overweight: A 12-week, randomized, controlled trial. *Psychiatry and Clinical Neurosciences*, *65*, 374–380.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Plos Medicine*, *6*, e 1000097.

Mokkink, L. B., Terwee, C. B., Patrick, D. L., Alonso, J., Stratford, P. W., Knol, D. L., et al. (2012). *COSMIN checklist manual.* (Retrieved from http://www.cosmin.nl website).

Moore, Charles H., & Crum, Blaine C. (1969). Weight reduction in a chronic schizophrenic by means of operant conditioning procedures: a case study. *Behavior Research and Therapy*, *7*, 129–131.

Orrell, A., Doherty, P., Miles, J., & Lewin, R. (2007). Development and validation of a very brief questionnaire measure of physical activity in adults with coronary heart disease. *European Journal of Preventative Rehabiliation*, *14*, 615–623.

Osborn, D. P. J., Nazareth, I., & King, M. B. (2007). Physical activity, dietary habits and coronary heart disease risk factor knowledge amongst people with severe mental illness. *Social Psychiatry and Psychiatric Epidemiology*, *42*, 787–793.

Pack, S. (2009). Poor physical health and mortality in patients with schizophrenia. *Nursing Standard*, *23*, 41–45.

Pambianco, G., Wing, R. R., & Robertson, R. (1990). Accuracy and reliability of the caltrac accelerometer for estimating energy expenditure. *Medicine and Science in Sport and Exercise*, *22*, 858–862.

Park, T., Usher, K., & Foster, K. (2011). Description of a healthy lifestyle intervention for people with serious mental illness taking second-generation antipsychotics. *International Journal of Mental Health Nursing*, *20*(6), 428–437.

Patterson, T. L., Kaplan, R. M., Grant, I., Semple, S. J., Moscona, S., Koch, W. L., et al. (1996). Quality of well-being in late-life psychosis. *Psychiatry Research*, *63*, 169–181.

Pelpham, T. W., Campagna, P. D., Ritvo, P. G., & Birnie, W. A. (1993). The effects of exercise therapy on clients in a Psychiatric Rehabilitation Program. *Pschosocial Rehabiliation Journal*, *16*, 76–84.

Plasqui, G., & Westerterp, K. R. (2007). Physical activity assessment with accelerometers: an evaluation against doubly labeled water. *Obesity*, *15*, 2371–2379.

Pope, C., Mays, N., & Popay, J. (2007). *Synthesizing qualitative and quantitative health research: A guide to methods.* Berkshire: McGraw-Hill.

Poulin, M. -J., Chaput, J. -P., Simard, V., Vincent, P., Bernier, J., Gauthier, Y., et al. (2007). Management of antipsychotic-induced weight gain: prospective naturalistic study of the effectiveness of a supervised exercise programme. *Australian and New Zealand Journal of Psychiatry*, *41*, 980–989.

Powell, S. M., Jones, D. I., & Rowlands, A. V. (2003). Technical variability of the RT3 accelerometer. *Medicine and Science in Sports and Exercise*, *35*, 1773–1778.

Powell, S. M., & Rowlands, A. V. (2004). Inter-monitor variability of the RT3 accelerometer during typical physical activities. *Medicine and Science in Sports and Exercise*, *36*, 324–330.

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *International Journal of Behaviour Nutritional and Physical Activity*, *5*, 1–24.

Ratliff, J. C., Palmese, L. B., Reutenauer, E. L., Liskov, E., Grilo, C. M., & Tek, C. (2012). The effect of dietary and physical activity pattern on metabolic profile in individuals with schizophrenia: a cross sectional study. *Comprehensive Psychiatry*, *53*, 1028–1033, http://dx.doi.org/10.1016/j.comppsych.2012.02.00.

Please cite this article as: Soundy, A., et al., Selection, Use and Psychometric Properties of Physical Activity Measures to Assess Individuals with Severe Mental Illness: A Narra..., *Archives of Psychiatric Nursing* (2014), http://dx.doi.org/10.1016/j.apnu.2013.12.002

Richardson, C. R. (2005). A lifestyle physical activity program for persons with serious mental illness. *Psychiatric Services*, *56*, 354.

Rodgers, M., Sowden, A., Petticrew, M., Arai, L., Roberts, H., Britten, N., et al. (2009). Testing methodological guidance on the conduct of narrative synthesis in systematic reviews. *Evaluation*, *15*, 49–74.

Rowlands, A. V., Thomas, P. W., Eston, R. G., & Topping, R. (2004). Validation of the RT3 triaxial accelerometer for the assessment of physical activity. *Medicine and Science in Sports and Exercise*, *36*, 518–524.

Sagatun, A., Søgaard, A. J., Bjertness, E., Selmer, R., & Heyerdahl, S. (2007). The association between weekly hours of physical activity and mental health: a three year follow up study of 15–16 year old students in the city of Oslo, Norway. *BMC Public Health*, *7*, 155.

Samele, C., Patel, M., Boydell, J., Leese, M., Wessely, S., & Murray, R. (2007). Physical illness and lifestyle risk factors in people with their first presentation of psychosis. *Social Psychiatry and Psychiatric Epidemiology*, *42*, 117–124.

Sanchez-Villegas, A., Ara, I., Guillén-Grima, F., Bes-Rastrollo, M., Varo-Cenarruzabeitia, J. J., & Martinez-Gonzalez, M. A. (2008). Physical activity, sedentary index, and mental disorders in the SUN cohort study. *Medicine and Science in Sports and Exercise*, *40*, 827–834.

Sarkin, J. A., Nichols, J. F., Sallis, J. A., & Calfas, K. J. (2000). Self-report measures and scoring protocols affect prevalence estimates of meeting physical activity guidelines. *Medicine and Science in Sports and Exercise*, *32*, 149–156.

Scheewe, T. W. (2008). Physical activity and cardiovascular fitness in patients with schizophrenia. *Paper presented at The Fourth European Congress of Psychomotricity*. The Netherlands: Amsterdam.

Scheewe, T. W., Van Haren, N. E. M., Takken, T., Backx, F. J. G., Kahn, R. S., & Cahn, W. (2011). Association between physical activity, cardiovascular fitness and global brain volumes in patients with schizophrenia. *European Neuropsychopharmacology*, *21*(Suppl 1).

Scott, D., & Happell, B. (2011). The high prevalence of poor physical health and unhealthy lifestyle behaviours in individuals with severe mental illness. *Issues in Mental Health Nursing*, *32*, 589–597.

Sharpe, J. -K. (2007). (PhD Thesis). *Body composition and energy expenditure in men with schizophrenia.* : Queensland University of Technology (Retrieved from http://eprints.qut.edu.au/16961/).

Sharpe, J. K., Stedman, T. J., Byrne, N. M., & Hills, A. P. (2006a). Accelerometry is a valid measure of physical inactivity but not of energy expended on physical activity in people with schizophrenia. *Schizophrenia Research*, *85*, 300–301.

Sharpe, J. K., Stedman, T. J., Byrne, N. M., Wishart, C., & Hills, A. P. (2006b). Energy expenditure and physical activity in clozapine use: implications for weight management. *The Australian and New Zealand Journal of Psychiatry*, *40*, 810–814.

Sheehan, D. V., Lecrubier, Y., Harnett-Sheehan, K., Amorim, P., Janavs, J., Weiller, E., et al. (1998). The Mini International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview. *Journal of Clinical Psychiatry*, *59*, 22–33.

Shephard, R. J. (2003). Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports Medicine*, *37*, 197–206.

Skrinar, G. S., Huxley, N. A., Hutchinson, D. S., Menninger, E., & Glew, P. (2005). The role of a fitness intervention on people with serious psychiatric disabilities. *Psychiatric Rehabilitation Journal*, *29*, 122–127.

Skrinar, G. S., Unger, K. V., Hutchinson, D. S., & Faigenbaum, A. D. (1992). Effects of exercise training in young adults with psychiatric disabilities. *Canadian Journal of Rehabilitation*, *5*, 151–157.

Sletten, I., Cazenave, M., & Gershon, S. (1967). Effects of caloric restriction on behavior and body weight during chlorpromazine therapy. *Diseases of the Nervous System*, *28*, 519–522.

Smith, S., Yeomans, C., Busche, C. J. P., Kriksson, C., Harrison, T., Holmes, R., et al. (2007). A well-being programme in severe mental illness. Baseline findings in a UK cohort. *International Journal of Clinical Practice*, *61*, 1971–1978.

SØrensen, M. (2006). Motivation for physical activity of psychiatric patients when physical activity was offered as part of treatment. *Scandinavian Journal of Medicine and Science in Sports*, *16*, 391–398.

Soundy, A. (2007). (PhD). *Understanding physical activity in individuals with severe mental illness*. Exeter: University of Exeter.

Soundy, A., Taylor, A., Faulkner, G., & Rowlands, A. (2007). Psychometric properties of the 7-Day Physical Activity Recall questionnaire in individuals with severe mental illness. *Archives of Psychiatric Nursing*, *21*(6), 309–316.

Stewart, A. L., Mills, K. M., King, A. C., Haskell, W. L., Gillis, D., & Ritter, P. L. (2001). CHAMPS physical activity questionnaire for older adults: Outcomes for interventions. *Medicine and Science in Sports and Exercise*, *33*, 1126–1141.

Strassnig, M., Brar, J. S., & Ganguli, R. (2011). Low cardiorespiratory fitness and physical functional capacity in obese patients with schizophrenia. *Schizophrenia Research*, *126*, 103–109.

Str hle, A., H fler, M., Pfister, H., MÜller, A. -G., Hoyer, J., Wittchen, H. -U., et al. (2007). Physical activity and prevalence and incidence of mental disorders in adolescents and young adults. *Psychological Medicine*, *37*, 1657–1666.

ten Have, M., de Graaf, R., & Monshouwer, K. (2011). Physical exercise in adults and mental health status findings from the Netherlands mental health survey and incidence study (NEMESIS). *Journal of Psychosomatic Research*, *71*, 342–348.

Terwee, C. B., Mokkink, L. B., Knol, D. L., Ostelo, R. W. J. G., Bouter, L. M., & de Vet, H. C. W. (2012). Rating the methodological quality in systematic reviews of studies on measurement properties: a scoring system for the COSMIN checklist. *Quality of Life Research*, *21*, 651–657.

Tetlie, T., Heimsnes, M. C., & Almvik, R. (2009). Using exercise to treat patients with severe mental illness. How and why? *Journal of Psychosocial Nursing*, *47*, 33–40.

Thyer, B. A., Irvine, S., & Snata, C. A. (1984). Contingency management of exercise by chronic schizophrenics. *Perceptual and Motor Skills*, *58*, 419–425.

Tyson, P., Wilson, K., Crone, D., Brailsford, R., & Laws, K. (2010). Physical activity and mental health in a student population. *Journal of Mental Health*, *19*(6), 492–499.

Upper, Dennis, & Newton, Judith G. (1971). Weight-reduction program for schizophrenic patients on a token economy unit - 2 case studies. *Journal of Behavior Therapy and Experimental Psychiatry*, *2*, 113–115.

Ussher, M. (2003). Psychosocial correlates of physical activity in psychiatric patients. *Paper presented at the Physical activity and mental health: a multidisciplinary approach program and abstract book, Dallas, Texas*.

Ussher, M. S. L., Cheeseman, V., & Faulkner, G. (2007). Physical activity preferences and perceived barriers to activity among those with severe mental illness. *Psychiatric Services*, *58*, 405–408.

Ussher, M., Doshi, R., Sampuran, A., & West, R. (2011). Cardiovascular risk factors in patients with Schizophrenia receiving continuous medical care. *Community Mental Health Journal*, *47*, 688–693.

Van Citters, A. D., Pratt, S. I., Jue, K., Williams, G., Miller, P. T., Xie, H., et al. (2010). A pilot evaluation of the In SHAPE individuals health promotion intervention for adults with mental illness. *Community Mental Health Journal*, *46*, 54–55.

Vancampfort, D., De Hert, M., Maurissen, K., Sweers, K., Knapen, J., Raepsaet, J., et al. (2011a). Physical activity participation, functional exercise capacity and self esteem in patients with schizophrenia. *International Journal of Therapy and Rehabilitation*, *18*, 222–229.

Vancampfort, D., Knapen, J., Probst, M., van Winkel, R., Deckx, S., Maurissen, K., et al. (2010a). Considering a frame of reference for physical activity research related to the cardiometabolic risk profile in schizophrenia. *Psychiatry Research*, *177*(271–279).

Vancampfort, D., Knapen, J., Probst, M., van Winkel, R., Deckx, S., Maurissen, K., et al. (2010b). Considering a frame of reference for physical activity research related to the cardiometabolic risk profile in schizophrenia. *Psychiatry Research*, *177*, 271–279.

Vancampfort, D., Probst, M., Knapen, J., Carraro, A., & De Hert, M. (2012). Associations between sedentary behavior and metabolic parameters in patients with schizophrenia. *Psychiatry Research*, *200*, 73–78, http://dx.doi.org/10.1016/j.psychres.2012.03.046.

Vancampfort, D., Probst, M., Scheewe, T., Maurissen, K., Sweers, K., Knapen, J., et al. (2011b). Lack of physical activity during leisure time contributes to an impaired health related quality of life in patients with schizophrenia. *Schizophrenia Research*, *129*, 122–127.

Vancampfort, D., Probst, M., Sweers, K., Maurisen, K., Knapen, J., & De Hert, M. (2011c). Relationships between obesity, functional exercise capacity, physical activity participation and physical self-perception in people with schizophrenia. *Acta Psychiatrica Scandinvica*, *123*, 423–430.

Vancampfort, D., Sweers, K., Probst, M., Maurissen, K., Knapen, J., Minguet, P., et al. (2011d). Association of the metabolic syndrome with physical activity performance in patients with schizophrenia. *Diabetes and Metabolism*, *37*, 318–323.

Vreeland, B., Minsky, S., Menza, M., Radler, D. R., Roemheld-Hamm, B., & Stern, R. (2003). A program for managing weight gain associated with atypical antipsychotic. *Psychiatric Services*, *54*, 1155–1157.

Walker, S. N., Sechrist, K. R., & Pender, N. J. (1995). *The health-promoting lifestyle profile II.* Nebraska, USA: University of Nebraska Medical Center, College of Nursing.

Walter, S. D., Eliaszi, M., & Donner, A. (1998). Sample size and optimal design for reliability studies. *Statistics in Medicine*, *17*, 101–110.

Walther, S., Federspiel, A., Horn, H., Razavi, N., Wiest, R., Dierks, T., et al. (2011). Resting state cerebral blood flow and objective motor activity reveal basal ganglia dysfunction in schizophrenia. *Psychiatry Research: Neuroimaging*, *192*, 117–124.

Walther, S., Horn, H., Razavi, N., Koschorke, P., MÜller, T. J., & Strik, W. (2009b). Quantitative motor activity differentiates schizophrenia subtypes. *Neuropsychobiology*, *60*, 80–86.

Walther, S., Koschorke, P., Horn, H., & Strik, W. (2009a). Objectively measured motor activity in schizophrenia challenges the validty of expert ratings. *Psychiatry Research*, *169*, 187–190.

Warren, J. M., Ekelund, U., Besson, H., Mezzani, A., Geladas, N., & Vanhees, L. (2010). Assessment of physical activity – a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. *Preventative Medicine*, *17*, 127–139.

Wichniak, A., Skowerska, A., Chojnacka-Wójtowicz, J., Tafliński, T., Wierzbicka, A., Jernajczyk, W., et al. (2011). Actigraphic monitoring of activity and rest in schizophrenic patients treated with olanzapine or risperidone. *Journal of Psychiatric Research*, *45*, 1381–1386.

Yamamoto, H., Yamamoto, K., Miyaji, S., Yukawa-Inui, M., Hori, T., Tatematsu, S., et al. (2011). Daily physical activity in patients with schizophrenia. *Kitasato Medical Journal*, *41*, 145–153.

Please cite this article as: Soundy, A., et al., Selection, Use and Psychometric Properties of Physical Activity Measures to Assess Individuals with Severe Mental Illness: A Narra..., *Archives of Psychiatric Nursing* (2014), http://dx.doi.org/10.1016/j.apnu.2013.12.002