Comportamiento sedentario, actividad física y condición física como herramientas complementarias en la evaluación y promoción de la salud de personas diagnosticadas con trastorno mental grave, y efectos de un programa de ejercicio físico sobre la condición física y composición corporal de presos psiquiátricos: el proyecto PsychiActive.

Sedentary behaviour, physical activity and fitness as complementary tools in the evaluation and promotion of health of people diagnosed with severe mental illness, and effects of an exercise program on fitness and body composition in psychiatric prison inmates: the PsychiActive project.

Javier Bueno Antequera

2018

Tesis Doctoral Internacional / International Doctoral Thesis

Departamento de Deporte e Informática. Área de Educación Física y Deportiva. Facultad de Ciencias del Deporte.

Universidad Pablo de Olavide, Sevilla (España)

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UNIVERSIDAD PABLO de OLAVIDE SEVILLA

Departamento de Deporte e Informática. Área de Educación Física y Deportiva.

Facultad de Ciencias del Deporte.

Universidad Pablo de Olavide

JAVIER BUENO ANTEQUERA

2018

A mi familia

Departamento de Deporte e Informática. Área de Educación Física y Deportiva.

Facultad de Ciencias del Deporte.

Universidad Pablo de Olavide

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Certifica:

Que la Tesis Doctoral titulada: "Comportamiento sedentario, actividad física y condición física como herramientas complementarias en la evaluación y promoción de la salud de personas diagnosticadas con trastorno mental grave, y efectos de un programa de ejercicio físico sobre la condición física y composición corporal de presos psiquiátricos: el proyecto PsychiActive" que presenta D. **JAVIER BUENO ANTEQUERA** al superior juicio del Tribunal que designe la Universidad Pablo de Olavide, ha sido realizada bajo mi dirección durante los años 2013-2018, siendo expresión de la capacidad técnica e interpretativa de su autor en condiciones tan aventajadas que le hacen merecedor del Título de Doctor, siempre y cuando así lo considere el citado Tribunal.

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Garantizamos, al firmar esta Tesis Doctoral, que el trabajo ha sido realizado por el doctorando bajo la dirección del director de la Tesis y hasta donde nuestro conocimiento alcanza, en la realización del trabajo, se ha respetado los derechos de otros autores al ser citados, cuando se han utilizado sus resultados o publicaciones.

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AYUDAS DE INVESTIGACIÓN [RESEARCH GRANTS]

El candidato ha recibido las siguientes ayudas de investigación durante la ejecución de la presente Tesis Doctoral Internacional:

- Ayudas Puente Predoctorales (Referencia: PPI1304). IV Plan Propio de Investigación de la Universidad Pablo de Olavide. Agencia financiadora: Universidad Pablo de Olavide. Desde 01/11/2013 hasta 09/09/2014.
- Ayudas para la Formación de Profesorado Universitario (Referencia: FPU13/05130). Resolución de 18 de noviembre de 2013 de la Secretaría de Estado de Educación, Formación Profesional y Universidades. Agencia financiadora: Ministerio de Educación, Cultura y Deporte. Desde 10/09/2014 hasta 09/09/2018.
- Ayudas para Estudiantes de Programas de Doctorado de la Escuela de Doctorado de la Universidad Pablo de Olavide (EDUPO), destinadas a cubrir gastos para la mejora cualitativa en el desarrollo de sus tesis doctorales, convocadas por Resolución de 26 de octubre de 2016.
- Ayudas para Estudiantes de Programas de Doctorado de la Escuela de Doctorado de la Universidad Pablo de Olavide (EDUPO), destinadas a cubrir gastos para la mejora cualitativa en el desarrollo de sus tesis doctorales, convocadas por Resolución de 14 de junio de 2016.
- Ayudas para Estudiantes de Programas de Doctorado de la Escuela de Doctorado de la Universidad Pablo de Olavide (EDUPO), destinadas a cubrir gastos para la mejora cualitativa en el desarrollo de sus tesis doctorales, aprobada por Resolución de 12 de junio de 2017 (Referencia: AMC-17-1).
- Ayudas para estudiantes de doctorado de la EDUPO para la realización de estancias en universidades o centros de investigación superior de reconocido prestigio, primando aquellas dirigidas a la realización de la tesis doctoral en régimen de cotutela y a la consecución de la mención internacional al título de doctor/a, convocadas por Resolución del Vicerrector de Postgrado y Formación Permanente de 12 de junio de 2017 (Referencia: AE-17-1).

PUBLICACIONES [PUBLICATIONS]

La presente Tesis Doctoral está compuesta por los siguientes trabajos:

1. **Bueno-Antequera J**, Oviedo-Caro MÁ, Munguía-Izquierdo D. Relationship between objectively measured sedentary behavior and health outcomes in schizophrenia patients: The PsychiActive project. Schizophr Res. 2018; 197:87-92.
2. **Bueno-Antequera J**, Oviedo-Caro MÁ, Munguía-Izquierdo D. Ideal cardiovascular health and its association with sedentary behaviour and fitness in psychiatric patients. The PsychiActive project. Nutr Metab Cardiovasc Dis. *In press.*
3. **Bueno-Antequera J**, Oviedo-Caro MÁ, Munguía-Izquierdo D. Sedentary behaviour, physical activity, cardiorespiratory fitness and cardiometabolic risk in psychosis: The PsychiActive project. Schizophr Res. 2018; 195:142-148.
4. **Bueno-Antequera J**, Oviedo-Caro MÁ, Munguía-Izquierdo D. Sedentary behaviour patterns in outpatients with severe mental illness: a cross-sectional study using objective and self-reported methods. The PsychiActive project. Psychiatry Res. 2017; 255:146-152.
5. **Bueno-Antequera J**. Recomendaciones para la promoción de la salud a través de estilos de vida activos en personas con trastorno mental grave. En Fundación Andaluza para la Integración Social del Enfermo Mental (coordina). Deporte y salud mental. La experiencia en Andalucía. Sevilla, España: Junta de Andalucía. *In press.*
6. **Bueno-Antequera J**, Munguía-Izquierdo D. Lifestyle changes and cardiovascular health in a woman with bipolar disorder: a case study of the PsychiActive project. In Stubbs B, Rosenbaum S (coord.). Exercise-Based Interventions for Mental Illness: Physical Activity as Part of Clinical Treatment. Amsterdam, Netherlands: Academic Press (Elsevier). Paperback ISBN: 9780128126059. *In press.*
7. **Bueno-Antequera J**, Oviedo-Caro MÁ, Munguía-Izquierdo D. Exercise improves fitness and anthropometrics measures in psychiatric men inmates: the PsychiActive project randomized controlled trial. *Submitted.*
8. **Bueno-Antequera J.** Efectos de un programa de ejercicio físico en pacientes con trastorno mental grave: the PsychiActive project. En Mendoza-Berjano R, Santos-Rocha R, Gil-Barcenilla B (coord.). La promoción de la actividad física en la sociedad contemporánea. Madrid, España: Díaz de Santos. *In press.*

RESUMEN

Los trastornos mentales graves, como la esquizofrenia, la depresión, la ansiedad y el trastorno bipolar, son una causa principal de discapacidad y muerte por cualquier causa a nivel mundial. La carga económica mundial de los trastornos mentales graves en 2010 fue comparable a la de las enfermedades cardiovasculares y superior a la del cáncer, las enfermedades respiratorias crónicas y la diabetes, y se espera que sea más del doble para 2030. Por lo tanto, reducir la creciente carga de los trastornos mentales graves es una prioridad de salud a nivel mundial.

El objetivo general de la presente Tesis Doctoral fue explorar la utilidad del comportamiento sedentario, actividad física y condición física para la evaluación y promoción de la salud en personas diagnosticas con trastorno mental grave, así como explorar la viabilidad y efectos de una intervención de ejercicio físico en presos psiquiátricos.

Los principales hallazgos fueron:

(1) En personas con esquizofrenia, un alto índice de masa corporal, una baja condición cardiorrespiratoria y peor puntación en el componente sumario físico se asociaron con un comportamiento más sedentario y el índice de masa corporal. La condición cardiorrespiratoria y la vitalidad fueron identificados factores determinantes del comportamiento sedentario. (2) Las personas con trastorno mental severo tuvieron una baja prevalencia de indicadores de salud cardiovascular ideal, especialmente la dieta y el índice de masa corporal. Bajos niveles de comportamiento sedentario, y altos niveles de condición cardiorrespiratoria y fuerza muscular se asociaron con un mayor puntaje de salud cardiovascular global, y solo la condición cardiorrespiratoria permaneció significativamente relacionada independientemente del comportamiento sedentario y la fuerza muscular. (3) En personas con psicosis, altos niveles de comportamiento sedentario y bajos niveles de actividad física y condición cardiorrespiratoria se asociaron con un mayor riesgo cardiometabólico agrupado, y solo la condición cardiorrespiratoria permaneció significativamente relacionada independientemente de los múltiples factores de confusión (incluyendo el comportamiento sedentario y la actividad física). Además, la condición cardiorrespiratoria y el comportamiento sedentario se asociaron con la circunferencia de la cintura y el comportamiento sedentario con los niveles de glucosa en sangre, siendo todas estas asociaciones independientes de las otras variables de interés. (4) Las personas con trastorno mental

severo experimentaron el 58% del tiempo despierto en comportamientos sedentarios, principalmente viendo la televisión. El método auto-reportado presentó una baja validez en comparación con el método objetivo, siendo más alto en los días entresemana para el grupo general y para los grupos de jóvenes, alta duración de la enfermedad y bajo nivel de medicación antipsicótica. (5) Las personas con trastorno mental grave deberían cumplir con la recomendación de 150 minutos de actividad física a la semana, reducir el tiempo en actividades sedentarias y tener niveles adecuados de condición física. Los cuestionarios International Physical Activity Questionnaire – short form, Sedentary Behaviour Questionnaire y el Test de caminar 6 minutos son herramientas sencillas y de bajo coste adecuadas para evaluar actividad física, comportamiento sedentario y condición física en esta población. (6) Cambios en el estilo de vida durante 18 meses, principalmente aumentando el nivel de actividad física y comer más saludablemente, mejoraron la salud cardiovascular y condición física y redujeron el comportamiento sedentario, peso corporal, síntomas psiquiátricos y el uso de medicación en una mujer con trastorno bipolar. (7) Una intervención grupal de 12 semanas de entrenamiento supervisado de ejercicio aeróbico y de fuerza fue segura, factible y efectiva para mejorar la condición cardiorrespiratoria, fuerza muscular y parámetros antropométricos en presos psiquiátricos. (8) Una intervención grupal de 12 semanas de entrenamiento supervisado de ejercicio aeróbico y de fuerza redujo la presencia de factores de riesgo cardiovascular en presos psiquiátricos.

Estos hallazgos ponen de manifiesto la utilidad del comportamiento sedentario, actividad física, condición física y ejercicio físico como herramientas complementarias en el tratamiento de personas con trastornos mentales graves.

ABSTRACT

Severe mental illness such as schizophrenia, depression, anxiety, and bipolar disorder are a leading cause of disability and all-cause death worldwide. The global economic burden of severe mental illness in 2010 was comparable to that of cardiovascular diseases and higher than that of cancer, chronic respiratory diseases, and diabetes, and is expected to more than double by 2030. Therefore, reducing the growing burden of severe mental illness is a global health priority.

The overall objective of the present Doctoral Thesis was explore the usefulness of sedentary behaviour, physical activity and fitness in the evaluation and promotion of health of people diagnosed with severe mental illness, as well as to explore the feasibility and effects of an exercise-based intervention in psychiatric inmates.

The main findings were: (1) In people with schizophrenia, a higher body mass index, a lower cardiorespiratory fitness and worse physical component score were associated with a more sedentary behaviour. Body mass index, cardiorespiratory fitness and vitality were identified as determinants of sedentary behavior. (2) People with severe mental illness had a low prevalence of ideal cardiovascular health metrics, especially diet and body mass index. Low sedentary behaviour, high cardiorespiratory fitness, high muscular strength levels were associated with higher global cardiovascular health score, and only cardiorespiratory fitness remained significantly related independent of sedentary behaviour and muscular strength. (3) In people with psychosis, high levels of sedentary behaviour and low levels of physical activity and cardiorespiratory fitness were associated with a higher clustered-cardiometabolic risk, and only cardiorespiratory fitness remained significantly related independent of multiple confounders (including sedentary behaviour and physical activity). Cardiorespiratory fitness and sedentary behaviour were associated with waist circumference and sedentary behaviour with fasting blood glucose, and all of these associations were independent of the other potential exposures. (4) People with severe mental illness spent 58% of waking time sedentary, primarily watching television. The self-reported method presented low validity compared to the objective method, being higher on weekdays for the overall group and for the younger, high illness duration and low antipsychotic medication groups. (5) People with severe mental illness should meet the recommended 150 minutes of physical activity per week, reduce time in sedentary activities and have adequate fitness levels. The International Physical Activity Questionnaire – short form, Sedentary Behavior Questionnaire and the 6-minute walk test are simple and low-cost

tools suitable for evaluating physical activity, sedentary behavior and fitness in this population. (6) A 18-month lifestyle changes, primarily increasing time engaged in physical activity and eating healthier, improved cardiovascular health and fitness, and reduced sedentary behaviour, body weight, severity of psychiatric symptoms and mediation use in a woman with bipolar disorder. (7) A 12-week group-based intervention of supervised aerobic and strength exercise training was safe, feasible, and effective for improving cardiorespiratory fitness, muscular strength, and anthropometric parameters in psychiatric men inmates. (8) A 12-week group-based intervention of supervised aerobic and strength exercise training was safe, feasible, reduced the presence of cardiovascular risk factors in psychiatric men inmates.

These findings highlight the usefulness of sedentary behaviour, physical activity, fitness, and exercise as complementary tools in the treatment of people with severe mental illness.

ABREVIATURAS [ABREVIATIONS]

6MWT: 6-Minute Walk Test.

ABSI: A Body Shape Index.

ANOVA: Analysis of variance.

BMI: Body mass index.

CCRS: Clustered-cardiometabolic risk.

CERT: Consensus on Exercise Reporting Template.

CFS: Composite fitness score.

CL: Confidence limit.

CONSORT: Consolidated Standards of Reporting Trials.

CRF: Cardiorespiratory fitness.

CVH: Cardiovascular health.

DBP: Diastolic blood pressure.

ES: Effect size.

FBG: Fasting blood glucose.

FFMI: Fat free mass index.

FMI: Fat mass index.

HDL-C: High-density lipoprotein cholesterol.

HRQoL: health-related quality of life.

ICD-10: International Statistical Classification of Diseases and Related Health Problems, 10th revision.

IDF: International Diabetes Federation.

IPAQ-SF: International Physical Activity Questionnaire – short form.

ISWT: Incremental Shuttle Walk Test.

ITT: Intention-to-treat analysis.

LPA: Light physical activity.

MCS: Mental component score of SF-36.

METS: Metabolic equivalent.

MetS: Metabolic syndrome.

MS: Muscular strength.

MVPA: Moderate-to-vigorous physical activity.

PA: Physical activity.

PCS: Physical component score of SF-36.

PP: Per protocol analysis.

SB: Sedentary behavior.

SBP: Systolic blood pressure.

SBQ: Sedentary Behaviour Questionnaire.

SD: Standard deviation.

SF-36: Short Form 36-Item Health Survey.

SWA: SenseWear.

TG: Triglycerides.

TMG: Trastono mental grave.

TPA: Total physical activity.

WC/Waist: Waist circumference.

Waist-hip: waist-to-hip ratio.

WHT5R/ waist-height$^{0.5}$: waist-to-height$^{0.5}$ ratio.

INTRODUCCIÓN [INTRODUCTION]

Definition of Severe mental illness (SMI)

SMI is defined as "a mental, behavioural, or emotional disorder resulting in serious functional impairment, which substantially interferes with or limits one or more major life activities" [1].

SMI - A global health issue

SMI such as schizophrenia, depression, anxiety, and bipolar disorder are a leading cause of disability [2] and all-cause death [3] worldwide. People with SMI have a greatly reduced life expectancy, up to 32 years [3], with cardiometabolic disease being the main contributor [4], and worse quality of life [5] compared to the general population. The global economic burden of SMI in 2010 was comparable to that of cardiovascular diseases and higher than that of cancer, chronic respiratory diseases, and diabetes, and is expected to more than double by 2030 [6]. Therefore, reducing the growing burden of SMI is a global health priority [7].

Two key factors for reducing the burden of SMI are (i) to improve the screening and monitoring of health and (ii) to promote health through active lifestyles.

Screening and monitoring of health of people with SMI

The European Psychiatric Association, supported by the European Association for the Study of Diabetes and the European Society of Cardiology [8] proposed to focus on traditional cardiovascular risk factors such as obesity, smoking, diabetes, hypertension, dyslipidaemia, and metabolic syndrome – all consistently more prevalent in people with SMI [8-10]. Because obesity alone is a strong and independent risk factor for cardiovascular disease mortality [11], can be measured easily and inexpensively through body mass index, waist circumference, between other anthropometric measures, losing weight and preventing obesity has long been promoted for health maintenance and improving the quality of life of people with SMI [12]. Nevertheless, a huge amount of research [13], including recent studies in people of SMI [14-16], sustains that improving physical fitness (defined as "a set of attributes that people have or achieve that related to the ability to perform physical activity" [17]) may be relatively more important, or at least as important, as preventing obesity. Specifically, a firmly established-base [18] recognized that low levels of cardiorespiratory fitness (defined as to the capacity of the cardiovascular and respiratory systems to supply oxygen to skeletal muscles during sustained activity [19]) is a stronger predictor of all-cause and disease-specific mortality than traditional cardiometabolic risk factors such as age, hypertension, hypercholesterolemia, obesity, smoking, family history, raised glucose and type 2 diabetes. Given the plethora of robust evidence supporting the prognostic use of cardiorespiratory fitness, the American Heart Association recently stated that cardiorespiratory fitness must be routinely assessed in clinical practice as a vital sign [20]. A growing body of evidence [21, 22] sustains that a low muscular strength (defined as the ability of a muscle to exert force [17]) is also a strong predictor of all-cause and disease-specific mortality, even independently of cardiorespiratory fitness [23]. For these reasons, cardiorespiratory fitness and muscular strength, both reduced in people with SMI [24, 25], should be highly considered for the evaluation and promotion of health.

Another interesting measure that might improve the screening and monitoring of health status of people with SMI is the ideal cardiovascular health. In 2010, the American Heart Association proposed a seven-item tool including health behaviours (smoking, body mass index, physical activity, and diet) and biological factors (blood pressure, total cholesterol, and glucose) to promote ideal cardiovascular health [26]. Several studies [27] have reported the prevalence of ideal cardiovascular health metrics in clinical and non-clinical populations and its negative association with cardiovascular and non-cardiovascular morbidity-mortality. However, no study is available on ideal cardiovascular health in people with SMI.

Promoting health through active lifestyles in people with SMI

A simple and low-cost method to improve health and quality of life is promoting active lifestyles. In general population, there is an established-evidence base indicating that higher levels of physical activity (defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” [17]) was associated with important and wide-ranging irrefutable health benefits [28, 29]. In addition, sedentary behavior (SB; defined as “any waking activity characterized by energy expenditure ≤1.5 metabolic equivalents while in a sitting or reclining posture” [30]), has been described as a major public health problem. In general population, there is a large-evidence base demonstrating that high levels of SB are associated with increased risk of all-cause, cardiovascular and cancer mortality, regardless of physical activity levels [31]. A recent global systematic review and meta-analysis highlighted that people with SMI engage in less physical activity and in more SB than the general population [32]. Therefore, increasing physical activity and reducing SB of people with SMI should be a global public health priority. Despite the impact of physical activity on the health of people with SMI has been broadly studied [33-37], the research on the association between SB and health in people with SMI is scarce. Furthermore, the few studies that used objective measures for assessing SB employed accelerometers as an objective indirect estimation of SB by measuring periods of reduced movement during waking hours identified from diaries and with accelerometer consecutive zero counts ≥60 minutes, which could misclassify sedentary time. In this regard, more research is needed, and preferentially using objective methods integrating acceleration and skin temperature information, to have more accurate estimations of time spent in SB [38].

An important aspect in improving the understanding of the impact of SB on the health of people with SMI is to study the possible associations between SB and health outcomes in people with SMI. As previously aforementioned, is well-known that people with SMI have worse health-related quality of life [5], higher prevalence of overweight/obesity (assessed as body mass index) [10], and impaired cardiorespiratory fitness [25] compared with the general population. However, little is known regarding the extent to which SB in people with SMI is associated with health-related quality of life and body mass index, and the relationship between SB and cardiorespiratory fitness remains unexplored. [STUDY 1]. Other important aspect is to evaluate whether SB is an independent health risk factor in people with SMI. In this respect, only one study [39] examined the independent associations of SB and physical activity with health in people with SMI, and showed that physical activity ameliorates the association between SB and cardiometabolic risk. Given that a recent ten-year follow-up study [40] in general adult population highlighted that cardiorespiratory fitness attenuates the association of SB and physical activity with cardiometabolic risk, fitness should be also considered when explore the possible association between SB and health. However, no study have explored the possible independence association of SB and fitness with health in people with SMI. [STUDIES 2 and 3]. Another important aspect is to combine both objective and self-reported methods for accurately quantifying SB patterns [41]. However, only one study in people with SMI [42] has combined both methods for assessing SB in this population, using a non-standardized questionnaire and accelerometers. Therefore, more research is needed, and preferentially using and comparing standardized domain-specific questionnaires, to capture high-risk SBs (e.g. watching television) [31], and objective methods integrating acceleration and skin temperature information, to have more accurate estimations of time spent in SB [38]. [STUDY 4].

In addition to promote active lifestyles [STUDIES 5 and 6], another method for improving the treatment and reducing the burden of SMI is exercise-based interventions [43, 44]. A plethora of evidence [45, 46] have consistently demonstrated that exercise-based interventions are a feasible, effective, and acceptable adjunct to usual care for a variety of SMI and provide benefits to both mental and physical health outcomes. However, despite the overwhelming burden of SMI in prison environments [47], which is associated with an increased risk of suicide, self-harm, violence, victimisation, somatic disorders, health care expenditures, and premature mortality on release from prison [47-49], very few exercise-based intervention studies have been done in this context, and none exclusively in inmates with SMI. Therefore, understanding the feasibility and effects of exercise-based interventions on the health of psychiatric inmates represents both a challenge and an opportunity for public health and the scientific community. [STUDIES 7 and 8]

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OBJETIVOS

El objetivo general de la presente Tesis Doctoral fue explorar la utilidad del comportamiento sedentario, actividad física y condición física para la evaluación y promoción de la salud en personas diagnosticas con trastorno mental grave, así como explorar la viabilidad y efectos de una intervención de ejercicio físico en presos psiquiátricos.

Los objetivos específicos de la presente Tesis Doctoral Internacional fueron:

- Investigar las posibles asociaciones entre comportamiento sedentario, calidad de vida, índice de masa corporal y condición cardiorrespiratoria e identificar variables que podrían explicar la variabilidad del comportamiento sedentario en pacientes con esquizofrenia. [ESTUDIO 1].
- Examinar las prevalencia de salud cardiovascular ideal en pacientes con trastorno mental grave y explorar las posibles asociaciones y asociaciones independientes entre comportamiento sedentario y condición física con la puntuación de salud cardiovascular ideal. [ESTUDIO 2].
- Explorar las posibles asociaciones independientes entre comportamiento sedentario, actividad física y condición cardiorrespiratoria con factor riesgo cardiovascular agrupado y factores de riesgo cardiovascular individuales en pacientes con psicosis. [ESTUDIO 3].
- Cuantificar y comparar patrones de comportamiento sedentario usando métodos objetivos y subjetivos en pacientes con trastorno mental estratificados por género, edad, índice de masa corporal, sintomatología, duración de la enfermedad y medicación antipsicótica. [ESTUDIO 4].
- Proporcionar recomendaciones para promover estilos de vida activos en personas con trastornos mentales graves. [ESTUDIO 5].
- Evaluar los efectos de cambios en el estilo de vida en una mujer con trastorno bipolar. [ESTUDIO 6].
- Evaluar la viabilidad y efectos de una intervención de ejercicio sobre medidas de condición física y antropometría en presos psiquiátricos. [ESTUDIO 7].
- Evaluar los efectos de una intervención de ejercicio sobre factores de riesgo cardiovascular en presos psiquiátricos. [ESTUDIO 8].

AIMS

The overall objective of the present Doctoral Thesis was explore the usefulness of sedentary behaviour, physical activity and fitness for the evaluation and promotion of health of people diagnosed with severe mental illness, as well as to explore the feasibility and effects of an exercise-based intervention in psychiatric inmates.

The specific objectives of the present Doctoral Thesis were:

- To investigate possible relationships between sedentary behavior and health-related quality of life, body mass index, and cardiorespiratory fitness, and to identify variables that could explain the variability in SB in schizophrenia patients. [STUDY 1].
- To examine the prevalence of ideal cardiovascular health in patients with severe mental illness and to explore the possible associations and independent associations of sedentary behaviour and fitness with ideal cardiovascular health score. [STUDY 2].
- To explore the possible independent associations of SB, PA, and CRF with clustered-cardiometabolic risk and individual-cardiometabolic risk factors in patients with psychosis. [STUDY 3].
- To quantify and compare sedentary behaviour patterns in patients with severe mental illness as stratified by gender, age, body mass index, distress, illness duration and antipsychotic medication using both objective and self-reported methods. [STUDY 4].
- To provide recommendations for promoting active lifestyles in people with severe mental illness. [STUDY 5].
- To evaluate the effects of lifestyle changes on health of a women with bipolar disorder. [STUDY 6].
- To evaluate the feasibility and effects of an exercise-based intervention on fitness and anthropometric measures in psychiatric men inmates. [STUDY 7].
- To evaluate the effects of an exercise-based intervention on cardiovascular risk factors in psychiatric men inmates. [STUDY 8].

MATERIAL Y MÉTODOS [MATERIAL AND METHODS]

La sección de material y métodos de la presente Tesis se resume en la siguiente tabla que incluye la información metodológica más relevante de los trabajos que la componen.

Table 1. Summary table of the main methodology used in the current Thesis.

	Paper	Type	Participants	Intervention	Main outcomes	Methods
1	Relationship between objectively measured sedentary behavior and health outcomes in schizophrenia patients: The PsychiActive project.	CS	82 (13 ♀) with schizophrenia.	No.	Sedentary behaviour, body mass index, health-related quality of life, fitness.	Multisensory-activity monitor, Anthropometry, Short Form-36 Health Survey, 6-minute walk test.
2	Ideal cardiovascular health and its association with sedentary behaviour and fitness in psychiatric patients. The PsychiActive project.	CS	142 (34 ♀) with various SMI.	No.	Ideal cardiovascular health (smoking, body mass index, physical activity, diet, blood pressure, cholesterol and glucose), sedentary behaviour, fitness.	Anthropometry, Multisensory-activity monitor, Mediterranean Diet Assessment Tool, Blood samples, Blood pressure wrist-monitor, 6-minute walk test, Handgrip dynamometry.
3	Sedentary behaviour, physical activity, cardiorespiratory fitness and cardiometabolic risk in psychosis: The PsychiActive project.	CS	43 (6 ♀) with psychosis: 32 with schizophrenia and 11 with bipolar disorders.	No.	Sedentary behaviour, physical activity, fitness, waist, blood pressure, triglycerides, high density lipoprotein cholesterol, glucose, cluster-cardiometabolic risk score.	Multisensory-activity monitor, 6-minute walk test, Anthropometry, Blood samples, Blood pressure wrist-monitor.
4	Sedentary behaviour patterns in outpatients with severe mental illness: a cross-sectional study using objective and self-reported methods. The PsychiActive project.	CS	90 (18 ♀) with various SMI.	No.	Sedentary behaviour.	Multisensory-activity monitor, Sedentary Behaviour Questionnaire.

Table 1. (cont.).

	Paper	Type	Participants	Intervention	Main outcomes	Methods
5	Recomendaciones para la promoción de la salud a través de estilos de vida activos en personas con trastorno mental grave.	PG	No.	No.	Physical activity, sedentary behaviour, fitness.	Evidence-base.
6	Lifestyle changes and cardiovascular health in a woman with bipolar disorder: a case study of the PsychiActive project.	Case	A woman with bipolar disorder.	18-month lifestyle changes on her own: increasing time engaged in physical activity and eating healthier.	Ideal cardiovascular health (smoking, body mass index, physical activity, diet, blood pressure, cholesterol and glucose), sedentary behaviour, fitness, severity of psychiatric symptoms, medication use.	Anthropometry, Multisensory-activity monitor, Mediterranean Diet Assessment Tool, Blood samples, Blood pressure wrist-monitor, 6-minute walk test, Arm-curl test, Chair-stand test, Brief Symptoms Inventory-18.
7	Exercise improves fitness and anthropometrics measures in psychiatric men inmates: the PsychiActive project randomized controlled trial.	RCT	41 psychiatric men inmates: usual care (n = 20), exercise + usual care (n = 21).	12 week, 3 times per week, 45 minutes of aerobic and strength exercise.	Attendance, dropout, fitness, weight, anthropometric and body composition indices.	6-minute walk test, Incremental Shuttle Walking Test, Handgrip dynamometry, Arm-curl test, Chair-stand test, Bioelectrical impedance, Anthropometry.
8	Efectos de un programa de ejercicio físico en pacientes con trastorno mental grave: the PsychiActive project.	RCT	52 psychiatric men inmates: usual care (n = 26), exercise + usual care (n = 26).	12 week, 3 times per week, 45 minutes of aerobic and strength exercise.	Glucose, cholesterol, triglycerides, anthropometric and body composition measures e indices, fitness.	Blood samples, Bioelectrical impedance, Anthropometry, 6-minute walk test, Handgrip dynamometry, Arm-curl test, Chair-stand test.

♀: women, Case: Case study, CS: Cross-sectional study, PG: Practical guideline, RCT: Randomized controlled trial, SMI: severe mental illness.

RESULTADOS Y DISCUSSIÓN [RESULTS AND DISCUSSION]

Los resultados y métodos de los trabajos que componen la presente Tesis se presentan en la forma que ha sido previamente publicados/sometidos.

1. Comportamiento sedentario, actividad física, y condición física en la evaluación de la salud de personas con trastorno mental grave. (Estudios 1, 2, 3 y 4).

ESTUDIO 1 [STUDY 1]

Relationship between objectively measured sedentary behavior and health outcomes in schizophrenia patients: The PsychiActive project.

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Relationship between objectively measured sedentary behavior and health outcomes in schizophrenia patients: The PsychiActive project

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ABSTRACT

This study aimed to investigate possible relationships between sedentary behavior and body mass index (BMI), cardiorespiratory fitness (CRF), and health-related quality of life (HRQoL) in schizophrenia patients. Variables contributing to the variability in sedentary behavior were identified. Eighty-two schizophrenia outpatients (mean age ± SD: 41.0 ± 8.7 years, 87% men, mean illness duration ± SD: 17.1 ± 8.9 years) wore a multisensor armband for 7 consecutive full days to objectively measure sedentary behavior. BMI, walking capacity (6-minute walking test) as a proxy for CRF estimation and HRQoL (Short Form 36-Item Health Survey questionnaire version 2) were also assessed. Correlation (Pearson or Spearman coefficients) and multiple regression analysis were used. Sedentary behavior was significantly associated with BMI, CRF, and the physical component summary score of HRQoL (r values, −0.34–0.41; all $P < 0.001$) and remained significant after adjustments for age, illness duration, symptom severity, adherence to Mediterranean diet, smoking, and antipsychotic medication (all $P < 0.05$). BMI, CRF and vitality were identified as determinants of sedentary behavior. Consistent relationships between sedentary behavior and BMI, CRF, and the physical component summary score of HRQoL were found in schizophrenia patients. All the identified determinants of sedentary behavior are modifiable and may be important areas for future interventions in this population.

1. Introduction

Sedentary behavior (SB), defined as any waking activity characterized by energy expenditure ≤1.5 metabolic equivalents while in a sitting or reclining posture (Sedentary Behaviour Research Network, 2012), has been described as a major public health problem (Blair, 2009). High levels of SB are associated with increased risk of morbi-mortality, independent of physical activity (Biswas et al., 2015). Recent meta-analyses reported that severe mental illness patients including schizophrenia were more sedentary than controls (Stubbs et al., 2016b; Vancampfort et al., 2017a). Despite the increased mortality (Walker et al., 2015), mainly due to cardiovascular disease (Correll et al., 2017; Vancampfort et al., 2016, 2015c), research on health effects of SB in schizophrenia patients is scarce.

A key factor in improving the understanding of the health effects of SB and the effectiveness of interventions aimed to reduce SB time in schizophrenia patients is to use adequate methods for quantifying SB. As aforementioned meta-analyses (Stubbs et al., 2016b; Vancampfort et al., 2017a) suggest, self-report measures fail to capture the SB levels in schizophrenia, highlighting the need to prioritize the use of objective measures to obtain more accurate results. However, few studies have utilized objective measures of SB in schizophrenia patients, and all existing studies included modest sample sizes ($n < 50$) (e.g., (Gomes et al., 2014; Janney et al., 2013; Snethen et al., 2014)), except for three recent inpatient studies (Chen et al., 2016; Stubbs et al., 2017b, 2017a). Therefore, studies that objectively measure SB in schizophrenia patients, including outpatient studies with relatively large sample sizes, are needed.

It is well-known that schizophrenia patients have worse health-related quality of life (HRQoL) (Foldemo et al., 2014), higher prevalence of overweight/obesity (assessed as body mass index; BMI) (Subramaniam et al., 2014), and impaired cardiorespiratory fitness (CRF) (Vancampfort et al., 2015b, 2017b) compared with the general population, largely as a result of unhealthy lifestyle choices such as lack of physical activity, poor diet, and smoking (Dipasquale et al., 2013; Stubbs et al., 2016a). However, little is known regarding the extent to which SB in schizophrenia patients is associated with BMI and HRQoL, and the relationship between SB and CRF remains unexplored.

The primary aim of this study was to investigate possible relationships between objectively measured SB and BMI, CRF, and HRQoL in schizophrenia patients. A secondary aim was to identify variables that could explain the variability in SB.

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2. Material and methods

2.1. Participants and setting

This was a cross-sectional study. From July 2014 to May 2016, adult outpatients with an established ICD-10 diagnosis of schizophrenia and stabilized on antipsychotic medication during the last month were recruited from 13 mental healthcare settings in southern Spain. Patients with clinical instability, co-morbid substance abuse, or evidence of uncontrolled cardiovascular, neuromuscular and endocrine disorders were excluded. Two visits per patient were scheduled. During the first appointment, anthropometric, sociodemographic, and medical record data were registered. In addition, patients were asked to wear a multisensor for 9 days, starting the same day they received the monitor. On day 9, during the second appointment, patients returned the monitor and completed standardized questionnaires about HRQoL, symptom severity, diet, and smoking. Finally, CRF was examined using a field-based test. The procedure was approved by the Universidad Pablo de Olavide Ethics Committee. All patients gave their informed written consent prior to enrolling and after receiving information about the study aims and protocol. There was no compensation for participation.

2.2. SB

SB that involved any waking activity characterized by energy expenditure ≤1.5 metabolic equivalents, was objectively assessed using the SenseWear Pro3 Armband (BodyMedia, Inc., Pittsburgh, PA, USA), previously used in non-clinical (Scheers et al., 2013) and clinical populations (Bond et al., 2011). Energy expenditure was accurately estimated (Johannsen et al., 2010) using data recorded from multiple sensors (a two-axis accelerometer and sensors measuring heat-flux, galvanic skin response and near body-temperature) and manufacturer-specific algorithms (SenseWear Professional software, version 8.1). Patients were required to wear the SenseWear on the triceps muscle of their left arm for 9 consecutive days, except when showering or swimming, and were asked to follow their usual lifestyle. The first and last days were excluded from the analysis to minimize reactivity (Corder et al., 2008). A total of 7 days of recording with a minimum of 1368 min per day (95% of a 24-hour period) was necessary for inclusion in the analysis. Although SB data are expressed both in minutes and as a percentage of waking time, only the relative SB time was used for analysis to account for individual differences in waking time.

2.3. Anthropometric data

Weight and height were measured with light clothing and without shoes to the nearest 0.1 kg and 0.1 cm using a scale (TANITA BC-420; Tanita, Tokyo, Japan) and a stadiometer, respectively, and BMI was calculated.

2.4. CRF

The 6-minute walking test, a feasible, reliable and valid method for assessing walking capacity in schizophrenia patients (Gomes et al., 2016), was used as a measure-of-proxy CRF estimation, as proposed by others (Vancampfort et al., 2015b). The test was performed according to Rikli and Jones (1999) on an indoor course with a flat, firm surface and with minimal external stimuli. Patients were instructed to walk as far as possible during a 6-minute period around a 45.7-meter rectangular course delimited by cones, without running or jogging. Resting was allowed if necessary, but walking was to be resumed as soon as possible. Standardized encouragements were used as recommended (Rikli and Jones, 1999). The same trained instructor explained the protocol, gave a demonstration prior to start, supervised the test and recorded the total distance walked to the nearest 0.1 m for each patient.

2.5. HRQoL

We used the Short Form 36-Item Health Survey version 2 (SF-36) (Ware and Sherbourne, 1992), which demonstrated good psychometric properties in schizophrenia patients (Su et al., 2014). The SF-36 examines eight domains of physical (physical functioning, physical role, body pain, and general health) and mental HRQoL (vitality, social functioning, emotional role, and mental health). The four physical-domains are summarized into a physical component score (PCS), and the four mental-domains constitute a mental component score (MCS). Scores range from 0 to 100, with higher scores indicating better HRQoL. A five-point difference (domain-scores) and two- to three-point difference (summary-scores) are considered clinically relevant (Ware et al., 1994).

2.6. Symptom severity

The severity of psychiatric symptoms during the previous week was assessed using the Brief Symptoms Inventory-18 (Derogatis, 2001), which is recommended as a more economical variant of the Symptom Checklist 90-R and as a clinically meaningful instrument (Prinz et al., 2013). Scores range from 0 to 72, with higher scores indicating higher severity.

2.7. Adherence to Mediterranean diet

We used the 14-Item Mediterranean Diet Tool (Martinez-Gonzalez et al., 2012) to assess the adherence to Mediterranean diet. Scores range from 0 to 14; scores ≥ 8 indicate high adherence, established as protective in terms of morbi-mortality (Sofi et al., 2014).

2.8. Smoking, illness-related factors and antipsychotic medication data

Smoking was self-reported. Age, diagnosis, illness duration, and antipsychotic medication were retrieved from patients' medical records. Antipsychotic medication was converted into a daily equivalent dosage of chlorpromazine (Gardner et al., 2010).

2.9. Statistical analysis

Student's *t*-test was used to calculate differences in SB according to gender, adherence to Mediterranean diet, and smoking. Patients were divided into low and high levels of SB using the median split, and Chi-square, Student's *t*, and Mann–Whitney *U* tests were applied to establish differences according to the nature and distribution of variables. Adjustments for multiple comparisons were made using the Bonferroni method by dividing the significance level of 0.05 by the number of comparisons; in this case, $0.05/20 = 0.0025$. To quantify relationships between SB and BMI, CRF or HRQoL, Pearson or Spearman correlation coefficients were used, depending on whether the data followed a normal distribution. Correlations were corrected for age, illness duration, symptom severity, adherence to Mediterranean diet, smoking, and antipsychotic medication. Correlation values were interpreted as follows: <0.25, weak or null; 0.25–0.50, fair; 0.50–0.75, moderate to good; and >0.75, good to excellent. Multiple stepwise regression model analysis was applied to identify significant determinants (independent variables) for SB (dependent variable). To prevent overfitting, significant correlates from the univariate tests were included in the model. Only patients with a complete dataset for the significant correlated variables were included in the multiple regression analysis. Variance inflation factor values > 3 were used to indicate a multicollinearity problem in the model (Kleinbaum et al., 2013). Graphic and statistical analyses of residuals were used to verify normality, linearity and homoscedasticity of the regression analysis. The data were analysed in 2016 using SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp).

3. Results

Eighty-two of the 95 (86%) participants had valid SenseWear data. Reasons for invalid SenseWear data included refusal to wear the device ($n = 1$), unregistered data attributed to technical problems ($n = 4$), and unmet wear-time criteria ($n = 8$). Patients' characteristics are summarized in Table 1. In total, 13%, 38% and 49% of the patients were normal-weight, overweight and obese, respectively. Mean percentage of waking time spent in SB was 58.7 (range 27.1–92.5) which corresponds to 8.8 h/day (range 3.9–13.2). No differences in SB were found between men and women (57.5 ± 13.7 and 65.3 ± 12.7% of waking time, respectively; $P = 0.061$), between non-smokers and current smokers (60.9 ± 13.3 and 56.9 ± 14.1%, respectively; $P = 0.190$) and between those with low and high adherence to Mediterranean diet (59.6 ± 12.6 and 59.6 ± 14.6%, respectively; $P = 0.995$).

Characteristic comparisons of SB levels are shown in Table 2. The high-SB group had a significantly higher BMI than the low-SB group ($P = 0.0018$). Differences in HRQoL were clinically significant for PCS, MCS, and almost all SF-36 domains.

The simple correlation model between SB and sample characteristics is presented in Table 3. Significant correlations with SB were found for symptom severity, BMI, CRF, and HRQoL, specifically in physical function, pain, and vitality domains and in PCS (all $P < 0.05$). The associations between BMI, CRF, and HRQoL remained significant after adjusting for age, illness duration, symptom severity, adherence to Mediterranean diet, smoking, and antipsychotic medication; exceptions were pain and vitality domains ($P = 0.329$ and 0.135, respectively; data not shown). Additional analysis found that the association between SB and CRF remained significant and fair even when BMI was included with the rest of the confounders ($P = 0.018$; data not shown).

Due to some missing data, a subsample of 74 patients (63 men and 11 women) with no changes in the correlation coefficients of the significant correlates (all $P < 0.05$; data not shown) was included in the multiple regression analysis (Table 4). Within the fully adjusted model, BMI, CRF, and vitality were identified as determinants of SB, explaining 37.4% of the SB variability. There was no multicollinearity among the variables within the final model.

Table 1
Patients' characteristics ($n = 82$).

Variables	Values
Age (years)	41.0 ± 8.7
Severity of psychiatric symptoms (0–72)[a,b]	15.6 ± 11.6
Illness duration (years)[a]	17.1 ± 8.9
Chlorpromazine equivalent dose (mg/day)[a]	756.8 ± 568.5
Sedentary time (% of waking time)	58.7 ± 13.8
Body mass index (kg/m^2)	30.7 ± 5.3
6-Minute walking test (m)[a]	589.6 ± 90.6
Short Form 36-Item Health Survey[a] (0 − 100)	
Physical function	73.7 ± 23.4
Physical role	72.4 ± 24.1
Pain	69.7 ± 23.8
General health	59.0 ± 22.9
Vitality	53.3 ± 21.7
Social function	63.6 ± 27.9
Emotional role	70.3 ± 28.0
Mental health	62.6 ± 20.7
Physical component summary	48.4 ± 9.1
Mental component summary	41.7 ± 12.3
Gender (women)	13 (15.9)
Adherence to Mediterranean diet (high)[a,c]	28 (39.4)
Smoking status (current smoker)	45 (54.9)
Marital status	
Married	2 (2.4)
Unmarried	74 (90.2)
Separated/divorced	6 (7.3)
Educational status	
Unfinished studies	16 (20.3)
Primary school	29 (36.7)
Secondary school	28 (35.4)
University degree	6 (7.6)
Occupational status	
Working	11 (13.6)
Unemployed	25 (30.9)
Retired	45 (55.6)

Values are in mean ± SD or n (%). Sedentary data are for an average day.
[a] Missing data. Reasons: Incomplete patient medical record data for illness duration and chlorpromazine equivalent dose ($n = 4$ and 9, respectively); incomplete questionnaire data for severity of psychiatric symptoms ($n = 4$), Short Form 36-Item Health Survey ($n = 3$), and adherence to the Mediterranean diet ($n = 11$); incomplete 6-minute walking test ($n = 1$).
[b] Severity of psychiatric symptoms was assessed using the Spanish version of the Brief Symptoms Inventory-18, with higher scores indicating high severity of psychiatric symptoms.
[c] Adherence to Mediterranean diet was assessed using the 14-Item Mediterranean Diet Tool, with scores ≥ 8 indicating high adherence to Mediterranean diet.

Table 2
Characteristic comparisons of sedentary behavior levels in schizophrenia patients.

Variables % or mean (SD)	Low sedentary		High sedentary		P[*]
	n[a]	Values	n[a]	Values	
Age (years)	41	40.7 ± 8.6	41	41.3 ± 8.9	0.7361
Severity of psychiatric symptoms (0–72)[b]	38	12.0 ± 10.3	40	19.1 ± 11.9	0.0045
Illness duration (years)	40	16.8 ± 7.7	38	17.4 ± 10.0	0.7692
Chlorpromazine equivalent dose (mg/day)	37	781.6 ± 633.3	36	731.3 ± 501.0	0.9340
Body mass index (kg/m^2)	41	28.8 ± 3.8	41	32.6 ± 6.0	0.0018[*]
6-Minute walking test (m)	41	611.9 ± 96.5	40	566.7 ± 78.9	0.0522
Short Form 36-Item Health Survey (0–100)					
Physical function	40	78.3 ± 24.2	39	69.1 ± 21.9	0.0200
Physical role	40	73.9 ± 23.0	39	70.8 ± 25.3	0.5847
Pain	40	74.7 ± 22.4	39	64.7 ± 24.4	0.0777
General health	40	64.0 ± 23.3	39	53.8 ± 21.6	0.0612
Vitality	40	59.7 ± 18.2	39	46.8 ± 23.3	0.0065
Social function	40	67.2 ± 23.5	39	59.9 ± 31.7	0.2825
Emotional role	40	70.8 ± 26.4	39	69.7 ± 29.8	0.9678
Mental health	40	65.0 ± 17.8	39	60.1 ± 23.4	0.2989
Physical component summary	40	50.4 ± 8.9	39	46.3 ± 9.1	0.0478
Mental component summary	40	42.9 ± 10.8	39	40.5 ± 13.8	0.3891
Gender (women)	41	4 (9.8)	41	9 (22.0)	0.1310
Adherence to Mediterranean diet (high)[c]	35	14 (40.0)	36	14 (38.9)	0.9242
Smoking status (current smoker)	41	26 (63.4)	41	19 (46.3)	0.1201

The sample was divided into low levels of sedentary behavior ($n = 41$, <59% of waking time, which corresponds to 7.3 h/day) and high levels of sedentary behavior ($n = 41$, ≥59% of waking time, which corresponds to 10.4 h/day) using the median split of the percentage of waking time spent engaging in sedentary behavior.
[a] n varies due to missing data. Reasons: Incomplete patient medical record data for illness duration and chlorpromazine equivalent dose ($n = 4$ and 9, respectively); incomplete questionnaire data for severity of psychiatric symptoms ($n = 4$), Short Form 36-Item Health Survey ($n = 3$), and adherence to the Mediterranean diet ($n = 11$); incomplete 6-minute walking test ($n = 1$).
[b] Severity of psychiatric symptoms was assessed using the Spanish version of the Brief Symptoms Inventory-18, with higher scores indicating high severity of psychiatric symptoms.
[c] Adherence to Mediterranean diet was assessed using the 14-Item Mediterranean Diet Tool, with scores ≥ 8 indicating high adherence to Mediterranean diet.
[*] Significant when $P < 0.0025$.

4. Discussion

The main findings are the identification of BMI, CRF, and vitality as determinants of SB, with higher BMI, lower CRF and worse PCS score associated with a more sedentary lifestyle. The statistical power of the correlations remained after adjustments for age, illness duration, symptom severity, adherence to Mediterranean diet, smoking, and antipsychotic medication, highlighting the importance of considering SB as a health risk behavior in schizophrenia patients.

The finding showing the association between SB and BMI in schizophrenia patients is consistent with previous studies that used self-reported SB (Vancampfort et al., 2014, 2012) but inconsistent with studies that used objective SB measurements (Janney et al., 2013;

Table 3
Relationship between sedentary behavior and sample characteristics.

Variables	n[a]	Correlation	P
Age (years)	82	−0.01	0.914
Severity of psychiatric symptoms (0–72)[b]	78	0.26	0.020*
Illness duration (years)	78	−0.04	0.736
Chlorpromazine equivalent dose (mg/day)	73	−0.11	0.377
Body mass index (kg/m^2)	82	0.41	<0.001*
6-Minute walking test (m)	81	−0.34	<0.001*
Short Form 36-Item Health Survey (0–100)			
Physical function	79	−0.35	0,002*
Physical role	79	−0.35	0,291
Pain	79	−0.24	0,036*
General health	79	−0.19	0,087
Vitality	79	−0.37	0,001*
Social function	79	−0.15	0,176
Emotional role	79	0.01	0,934
Mental health	79	−0.13	0,240
Physical component summary	79	−0.35	<0.001*
Mental component summary	79	−0.08	0,480
Gender (men/women)	82	0.21	0.061
Adherence to Mediterranean diet (low/high)[c]	71	0.00	0.995
Smoking status (non-smoker/current smoker)	82	0.15	0.190

Correlation values are either Pearson or Spearman correlations.
[a] n varies due to missing data. Reasons: Incomplete patient medical record data for illness duration and chlorpromazine equivalent dose ($n = 4$ and 9, respectively); incomplete questionnaire data for severity of psychiatric symptoms ($n = 4$), Short Form 36-Item Health Survey ($n = 3$), and adherence to the Mediterranean diet ($n = 11$); incomplete 6-minute walking test ($n = 1$).
[b] Severity of psychiatric symptoms was assessed using the Spanish version of the Brief Symptoms Inventory-18, with higher scores indicating high severity of psychiatric symptoms.
[c] Adherence to Mediterranean diet was assessed using the 14-Item Mediterranean Diet Tool, with scores ≥ 8 indicating high adherence to Mediterranean diet.
* Significant when $P < 0.05$.

Snethen et al., 2014). The lack of association between SB and BMI in the aforementioned studies could be explained by the limited statistical power of the sample size ($n < 50$), the ceiling effect observed for BMI (Janney et al., 2013; Snethen et al., 2014) or the use of different devices and requirements to evaluate objective SB. Other research in schizophrenia (Stubbs et al., 2017b) also found no association between SB objectively measured and waist circumference, suggested as a better predictor of cardiovascular risk than BMI (Janssen et al., 2004). Nonetheless, current studies reported that no obesity index is consistently superior to others (Lam et al., 2015) and that the combined obesity indices had a better predictive capacity than either alone (Tao et al., 2016). Future studies investigating the association between combined obesity indices and SB measured objectively through energy expenditure and body position for multiple and consecutive 24-hour periods are necessary to gain better insights into this issue.

The finding demonstrating the relationship between SB and BMI independent of various confounders, including diet, may be explained by the use of total SB time instead of time spent engaging in certain SBs such as television viewing, that are associated with weight gain mediated by unhealthy dietary patterns (de Rezende et al., 2014). Future research combining both objectively measured and self-reported SB patterns using appropriate tools (Bueno-Antequera et al., 2017a) is required to improve the understanding of the impact of specific SBs on BMI and on other health outcomes of schizophrenia patients.

Table 4
Final model of the backward stepwise regression analysis with the mean percentage of waking time spent engaging in sedentary behavior as the dependent variable ($n = 74$).

Variables[a]	B	SE	β	t	VIF	P
(Constant)	61.12	14.45		4.23		
Body mass index	0.93	0.26	0.35	3.50	1.15	0.001*
6-Minute walking test	−0.04	0.02	−0.24	−2.28	1.27	0.026*
Vitality	−0.16	0.07	−0.25	−2.53	1.13	0.014*

B: unstandardized coefficient; β: standardized coefficient; SE: standard error; VIF: variance inflation.
[a] Only significant correlates in the univariate tests were included in the model (severity of psychiatric symptoms, body mass index, 6-minute walking test, physical function, pain, vitality and physical component summary).
* Significant when $P < 0.05$.

A significant relationship between SB and CRF can be expected because SB has a deleterious impact on circulatory, respiratory and muscular systems (Allen et al., 1999) involved in CRF. Similar results have been recently found in psychosis patients (Bueno-Antequera et al., 2017b), and the association persisted even when BMI was included with the rest of the confounders. These findings are of clinical interest because a low CRF is associated with an enhanced risk of cardiovascular disease, all-cause mortality, and mortality rates attributable to various cancers (Ross et al., 2016). Therefore, regardless of BMI, reducing SB may protect against two critical health issues in schizophrenia patients - impaired CRF (Vancampfort et al., 2015b) and elevated premature mortality (Olfson et al., 2015) - suggesting a shift in clinical focus from fatness towards fitness in this population, as previously proposed (Vancampfort et al., 2017b). Future research should investigate whether these findings are applicable considering other health-related fitness components, such as muscular strength, which is also impaired in schizophrenia patients (Vancampfort et al., 2013) and is related to mortality (Volaklis et al., 2015).

The significant association between SB and the HRQoL PCS score could be attributable to a higher BMI and lower CRF in more sedentary patients (see Table 3), which were significantly related to the HRQoL PCS (r = −0.27 and 0.43, respectively; both $P < 0.05$; data not shown), consistent with previous research in schizophrenia patients (Vancampfort et al., 2015a). In addition to the PCS, lower clinically relevant scores for MCS were found in the high-SB group, suggesting possible associations between mental aspects of HRQoL and SB in line with a longitudinal study of older adults (Balboa-Castillo et al., 2011). These results are inconsistent with the one study that investigated the relationship between SB and HRQoL in schizophrenia patients (Gomes et al., 2014). The small sample size employed ($n = 8$) in the aforementioned study (Gomes et al., 2014) and the use of different tools to measure HRQoL and SB may explain the discrepancy.

Finally, the relationship between SB and symptom severity did not remain significant in the multiple regression model, suggesting that its importance in SB in schizophrenia patients is weak and can be explained by its interaction with other variables. All the identified determinants of SB are modifiable and may be important areas for future interventions in this population. It should be noted that our model only explained approximately a third of variability in SB suggesting that other outcomes not included in this study such as the socioeconomic (Stamatakis et al., 2014), geographical (Vancampfort et al., 2017a), and environmental status (Vancampfort et al., 2014) could explain part of the remaining variability.

As for clinical implications, this study could help to raise health professionals' awareness of the importance of reducing excessive SB in schizophrenia patients. However, randomized controlled trials aimed to reduce SB in schizophrenia patients are needed to determine whether reduced health outcomes can be improved (Williams et al., 2016). Researchers should consider all reported determinants of SB in this work when designing trials.

The findings need to be interpreted cautiously. The major limitation of this study is the cross-sectional design. Longitudinal and intervention studies are needed to identify any causal relationships. The convenience sample of outpatients, predominantly men, may also affect generalization. Future research should determine whether the results are also applicable in inpatient settings and for women with schizophrenia. The absence of a control group is an additional limitation. The objective SB measurement employed also presents limitations. The SenseWear device is unable to differentiate body position (i.e., sitting, lying, and standing). However, it may solve the limitations of accelerometers and inclinometers through heat production measurements and placement on the upper arm. Further studies using multiple sensors and inclinometers simultaneously should be performed to objectively measure SB. CRF was estimated through a submaximal exercise test that evaluates walking capacity. Future studies should confirm our findings using maximal or submaximal tests with direct measurement of peak oxygen uptake, the gold standard for CRF assessment (Vanhees et al., 2005). Finally, data on symptom severity and diet were collected with self-report questionnaires. This may involve recall bias (Raphael, 1987) that could be even more pronounced in schizophrenia patients, who are prone to memory and cognitive difficulties (Hill et al., 2013).

Despite these limitations, this study has strengths. Major strengths of this multicenter study are the relatively large sample size and the strict requirements used to measure SB. All patients wore the SenseWear for 7 consecutive days with at least 1368 min/day of registered time, and reactivity was minimized. Another strength was the adjustment for confounders that could influence the relationships between SB and BMI, CRF, and HRQoL. These include age, illness duration, symptom severity, adherence to Mediterranean diet, smoking, and antipsychotic medication. Finally, using the relative SB time to avoid the potential confounding influence of waking time could be considered another strength.

In conclusion, consistent relationships between higher SB and higher BMI, lower CRF and worse HRQoL PCS scores were found in schizophrenia patients. In addition, lower clinically relevant scores for HRQoL PCS and MCS were found in the high-SB group. Finally, BMI, CRF, and vitality were identified as determinants of SB. Therefore, reducing SB may lead to improvements in health outcomes that are commonly impaired in schizophrenia patients.

Conflict of interest

All authors declare no conflicts of interest.

Contributors

DM designed the study and wrote the protocol. All authors were responsible for the acquisition of the data. JB and DM performed the statistical analyses and wrote the manuscript. All authors provided critical review of the manuscript and approved the final version.

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ESTUDIO 2 [STUDY 2]

Ideal cardiovascular health and its association with sedentary behaviour and fitness in psychiatric patients. The PsychiActive project.

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Ideal cardiovascular health and its association with sedentary behaviour and fitness in psychiatric patients. The PsychiActive project

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Abstract *Background and aims:* Ideal cardiovascular health (CVH) was defined as meeting ideal levels of 4 health behaviours (smoking, body mass index, physical activity, and diet) and 3 biological factors (blood pressure, total cholesterol, and glucose) and is inversely related to cardiovascular disease and mortality. However, the prevalence of ideal CVH in patients with severe mental illness and the possible independent associations of sedentary behaviour and fitness with CVH score are unexplored.

Methods and results: This study included 142 (34 women) outpatients with severe mental illness (primarily schizophrenia, n = 92). CVH was evaluated according to the American Heart Association guidelines. Sedentary behaviour, cardiorespiratory fitness, and muscular strength were measured by an activity-monitor, the 6-min walk test, and handgrip dynamometry. Cardiorespiratory fitness and strength values were combined in a composite fitness score. The prevalence of ideal CVH was: non-smoking (47.9%), body mass index (16.9), physical activity (83.1%), diet (10.4%), blood pressure (40.4%), total cholesterol (62.9%), and plasma glucose (66.7%). Low levels of sedentary behaviour and high cardiorespiratory, strength, and composite fitness score were associated with meeting the ideal threshold in most CVH metrics and having higher global CVH score; however, only cardiorespiratory and composite fitness score remained significantly related to global CVH score independent of sedentary behaviour and multiple confounders.

Conclusions: Patients with severe mental illness generally have low prevalence of ideal CVH metrics, especially diet and body mass index. Additionally, our findings suggest the need or considering cardiorespiratory fitness, regardless of sedentary behaviour, to promote ideal CVH in this population.

Introduction

Cardiovascular disease is a leading cause of death worldwide and poses substantial social, economic and health burdens. Compared to the general population, patients with severe mental illness (SMI) have an increased risk of mortality due to cardiovascular disease [1]. These findings

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sustain that public health efforts to reduce the burden of cardiovascular disease risk factors have not been effective in the SMI population, thus highlighting the need for better prevention and treatment strategies.

In 2010, the American Heart Association proposed a seven-item tool including health behaviours (smoking, body mass index, physical activity, and diet) and biological factors (blood pressure, total cholesterol, and glucose) to promote ideal cardiovascular health (CVH) [2]. Several studies [3] have reported the prevalence of ideal CVH metrics in clinical and non-clinical populations and its negative association with cardiovascular and non-cardiovascular morbidity-mortality. However, no study is available on ideal CVH in patients with SMI to advance the development of effective intervention strategies.

A plethora of evidence strongly indicates that high sedentary behaviour (SB) [4] and low fitness [5] levels are predictors of all-cause and cardiovascular mortality, independent of physical activity level and other confounders. However, there is insufficient evidence on the association of SB [6,7] and fitness [8–10] with ideal CVH, and the independent association of both exposures with ideal CVH remain unexplored. Patients with SMI have higher SB [11] and lower fitness [12] levels than controls, and although some studies (e.g., [13,14]) have explored their association with CVH outcomes, their independent role has received little attention. Therefore, increasing knowledge of the impact of sedentary behaviour and fitness on the ideal CVH could help raise awareness among policy makers, practitioners, researchers, and the general public about the importance of maintaining an active lifestyle for health. The aims of this study were (i) to examine the prevalence of ideal CVH in patients with SMI and (ii) to explore the possible associations and independent associations of SB and fitness with ideal CVH score.

Methods

Study design and participants

From July 2014 to July 2017, all patients from 14 different outpatient mental healthcare settings in southern Spain were invited to participate. Project pamphlets and posters were placed in waiting rooms, and interested people contacted the researchers directly or through staff members. A convenience sample of adults with a range of established ICD-10 SMI diagnoses (see Table 1), stabilized on antipsychotic medication during the last month were included in this study. Patients with clinical instability, substance abuse, or comorbidities contraindicating participation were excluded. Participants were required to undergo anthropometric, fitness, and blood measurements, wear an activity monitor, and complete questionnaires about sociodemographic characteristics as well as smoking, diet, and symptomatology severity. Personal medical records were also reviewed. The study procedure was approved by the Hospitales Universitarios Vírgen Macarena and Virgen del Rocío Ethics Committee (1674-N-17). All patients gave their informed written consent prior

Table 1 Characteristics of the participants (n = 142).

Variables	Values
Age (years)	41.4 ± 9.1
Body mass (kg)	88.8 ± 17.8
Height (cm)	171.6 ± 8.3
Body mass index (kg/m^2)	30.1 ± 5.7
Sedentary behaviour (min/day, % of waking time/day)[a]	540 ± 138 (58.8)
6-min walk test (m)[a]	600.9 ± 102.4
Handgrip strength (kg)	42.8 ± 10.9
Relative handgrip strength (strength/body mass, both in kg)	0.49 ± 0.13
Systolic blood pressure (mm Hg)[a]	121.4 ± 15.9
Diastolic blood pressure (mm Hg)[a]	79.4 ± 10.6
Glucose (mg/dL)[a]	101.2 ± 32.3
Total cholesterol (mg/dL)[a]	192.3 ± 33.3
Adherence to Mediterranean diet (0–14)[a,b]	6.7 ± 2.2
Moderate-vigorous physical activity (min/week)[a,c]	570.1 ± 509.2
Psychopathological severity (0–72)[d]	15.6 ± 13.1
Chlorpromazine equivalent dose (mg/day)[a]	573.7 ± 565.0
Illness duration (years)[a]	15.6 ± 9.1
Gender (women)	34 (23.9)
Smoking (current smoker)	74 (52.1)
Race (Caucasian)	142 (100)
Diagnoses[a]	
Schizophrenia, schizotypal and delusional disorders	92 (67.2)
Mood [affective] disorders	27 (19.7)
Disorders of adult personality and behaviour	9 (6.6)
Neurotic, stress-related and somatoform disorders	5 (3.6)
Mental retardation	2 (1.5)
Disorders due to psychoactive substance use	2 (1.5)
Marital status[a]	
Married	10 (7.3)
Unmarried	111 (81.0)
Separated/divorced	16 (11.7)
Educational status[a]	
Primary school or less	71 (53.4)
Secondary school or more	62 (46.6)
Occupational status[a]	
Working	22 (16.3)
Unemployed	43 (31.9)
Retired	70 (51.9)

NOTE. Values are the mean ± SD or n (%).

[a] Missing data. Reasons: Refusal to wear the SenseWear to assess physical and sedentary behaviours (n = 8) and to undergo blood glucose and cholesterol determinations (n = 66); unregistered data attributed to technical problems to assess physical and sedentary behaviours (n = 3), blood pressure (n = 1), and cholesterol (n = 6); unmet SenseWear wear-time criteria to assess physical and sedentary behaviours (n = 13); incomplete 6-min walk test (n = 1); incomplete patient medical record data for diagnoses, illness duration, chlorpromazine equivalent dose (n = 5, 16 and 17, respectively); and incomplete questionnaire data for adherence to the Mediterranean diet (n = 17), psychopathological severity (n = 13), marital (n = 5), educational (n = 9), and occupational status (n = 7).

[b] Adherence to the Mediterranean diet was assessed using the 14-Item Mediterranean Diet Tool, with higher scores indicating a high adherence.

[c] Moderate-vigorous physical activity accumulated in bouts of ≥10 min.

[d] Psychopathological severity was assessed using the Brief Symptoms Inventory-18, with higher scores indicating greater severity.

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to enrolling in the study and after receiving information about the aims and protocol. There was no compensation for participation.

Ideal CVH

Health behaviours

Smoking was self-reported, and patients classified as non-smokers were categorized as having an ideal smoking status. Body mass index was calculated using weight and height measured to the nearest 0.1 kg and 0.1 cm using a scale (TANITA BC-420; Tanita, Tokyo, Japan) and a stadiometer, respectively, and ideal body mass index was considered <25 kg/m^2. Ideal diet was defined as high adherence to the Mediterranean diet, which has been proven to be protective in terms of morbi-mortality [15], instead of the ideal diet concept that was originally proposed [2]. To classify individuals with high adherence, we used a score $\geq$10 in the 14-Item Mediterranean Diet Tool [16] as previously considered [16,17]. Physical activity was measured objectively with the SenseWear Pro3 Armband (BodyMedia, Inc., Pittsburgh, PA, USA), a multisensory-activity monitor that uses manufacturer-specific algorithms (SenseWear Professional software version 8.1; BodyMedia, Inc., Pittsburgh, PA, USA) to estimate energy expenditure. Patients were required to wear this device on their left arm triceps muscle for nine consecutive days, 24 h/day, except when showering or swimming, and were asked to follow their usual lifestyle. The first and last days were excluded from the analysis to minimize reactivity. Seven days with a minimum registration of 1368 min/day (95% of a 24-h period) were necessary to be included in the analysis, as previously considered in this population [13]. Ideal physical activity was considered $\geq$150 min/week of moderate-to-vigorous physical activity ($>$3.0 metabolic equivalents) accumulated in bouts of $\geq$10 min.

Biological factors

The following *factors* were collected by trained staff in the morning after an overnight fast. Blood pressure was measured in a seated position after a 10-min rest period with a wrist-monitor (HEM-6221-E, Omron Healthcare Europe BV, Hoofddorp, the Netherlands) placed on the left arm. The mean of two measures was used for analysis. If the two measures differed by $\geq$20 mm Hg for systolic and $\geq$10 mm Hg for diastolic blood pressure, a third measurement was taken, and the median of the three measurements was used. Ideal blood pressure was considered $<$120 mmHg systolic and $<$80 mmHg diastolic. Total cholesterol $<$200 mg/dL and glucose concentrations $<$100 mg/dL were considered ideal.

CVH score

According to American Heart Association criteria [2], global (ranging from 0 to 7), behavioural (0–4), and biological (0–3) CVH scores were computed as the sum of the metrics, in which the ideal threshold was met (i.e., 1 point for each).

SB

SB (min/day), considered any waking activity with an energy expenditure $\leq$1.5 metabolic equivalents, was obtained from the same dataset under the same requirements used for physical activity measurement.

Fitness

Cardiorespiratory fitness (CRF) was assessed by the 6-min walk test according to Rikli and Jones [18] on an indoor course with a flat, firm surface and with minimal external stimuli. Patients were instructed to walk as far as possible during a 6-min period around a 45.7-m rectangular course delimited by cones, without running or jogging. Resting was allowed if necessary, but walking was to be resumed as soon as possible. Standardized encouragements were used, as recommended [18]. The same trained instructor explained the protocol, gave a demonstration prior to start, supervised the test and recorded the total distance walked to the nearest 0.1 m for each patient. A multimedia explanation is available on the link below: https://upotv.upo.es/video/5936500f238583f9658b464a.

Muscular strength (MS) was assessed to the nearest 0.1 kg with a hand dynamometer (TKK 5401 Grip-D, Takey, Tokyo, Japan). Patients in erect stance and with the arm in complete extension were instructed to squeeze the handle as fast and as hard as possible for 5 s while receiving verbal encouragement. The test was performed twice (alternately with both hands) with a 1-min rest between trials, and the maximum value of the four attempts was used. To account for individual differences in body mass, we have used relative grip strength (i.e., handgrip strength/body mass, both in kg) for the analysis.

Additionally, a composite fitness score was constructed by averaging the standardized values of distance walked during the 6-min test and relative handgrip strength. Scores above zero represent a higher fitness level.

Sociodemographic characteristics and other clinical data

Marital, educational, and occupational status were self-reported. Age, diagnosis, illness duration, and medication were obtained from the patients' medical records. Antipsychotic medication was converted into chlorpromazine equivalent dose [19]. The Global Severity Index of the Brief Symptoms Inventory-18 [20] was used to assess psychopathological severity over the past week. Illness duration, chlorpromazine equivalent dose and psychopathological severity will be referred to as 'illness-related-factors' henceforth.

Statistical analysis

The proportion of ideal CVH metrics was calculated overall and for groups, stratified by gender, by high or low levels according to age and single illness-related-factors using median splits. Chi-square and Fisher exact tests were applied to examine differences in the proportion of ideal

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CVH metrics. Differences in SB and fitness levels between ideal and non-ideal CVH metrics were assessed by analysis of covariance, with the aforementioned variables as dependent variables, CVH metric (ideal vs. non-ideal) entered as a fixed factor, and age and gender as covariates. The analysis of covariance was repeated adding illness-related-factors, as covariates. Multiple linear regression analysis, including patients with complete data on the seven CVH metrics, was used to examine the associations of SB and fitness levels, with CVH scores adjusted for gender and age. Furthermore, SB and fitness outcomes, as applicable, were added to the models. When exploring the role of the behavioural and biological CVH scores, the analysis was also adjusted for the status (ideal or non-ideal) of the rest metrics (analysis without this adjustment is available as supplemental material 1). The regression analysis was repeated including education and illness-related factors in the models. Residuals were tested for homoscedasticity, linearity and independence. The variance inflation factor never exceeded three, indicating that multi-collinearity was not a concern. Data were analysed using SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp), with statistical significance set at $\alpha = 0.050$.

Results

One hundred forty-two patients with SMI aged between 18 and 61 years participated, and their characteristics are summarized in Table 1. The prevalence of ideal CVH metrics stratified by gender, age, and illness-related-factors are presented in Table 2. Most had ideal physical activity levels (83.1%), whereas less than 20% had ideal body mass index (16.9%) and diet (10.4%). More than half of the patients had ideal glucose (66.7%) and cholesterol (62.9%) levels, whereas less than half had an ideal smoking status (47.9%) and blood pressure (40.4%). Compared with their counterparts, men had a lower prevalence of ideal blood pressure and glucose, the older age group had a lower prevalence of ideal blood pressure, and those with high chlorpromazine equivalent dose had a lower prevalence of ideal smoking status (all $P < 0.050$).

Table 3 shows sedentary behaviour and fitness estimates by ideal CVH metrics. Levels of SB were lower in those who met ideal CVH metrics (all $P \leq 0.01$), except for smoking status and diet. After adding illness-related-factors as covariates, the differences remained significant (all $P < 0.050$; data not shown). Levels of CRF were higher in those who met ideal body mass index, physical activity, diet, and blood pressure (all $P < 0.050$). After adding illness-related-factors as covariates, differences in body mass index and diet became non-significant ($P = 0.074$ and $P = 0.166$, respectively; data not shown), and differences in smoking status became significant ($P = 0.013$; data not shown). Levels of MS were higher in those who met ideal body mass index, cholesterol, and blood pressure (all $P < 0.050$). After adding illness-related-factors as covariates, the differences remained significant (all $P < 0.050$; data not shown), except for cholesterol ($P = 0.151$; data not shown). Composite fitness scores were higher in those who met ideal CVH metrics (all $P < 0.050$), except for smoking, diet, and glucose. After adding illness-related-factors as covariates, the differences remained significant (all $P < 0.050$; data not shown).

Among the 54 patients (43 men, 38 with schizophrenia, mean [range] age 41.5 ± 8.6 [18–59] years) with complete data on the seven CVH metrics, only one individual had 0 of the 7 ideal metrics, 42 (77.7%) had <5, and none had all 7 ideal CVH metrics. The results of the multivariate analysis to explore the associations of SB and fitness with CVH scores are shown in Table 4. Lower levels of SB were associated with higher global ($\beta = -0.41$, $P = 0.002$) and biological ($\beta = -0.37$, $P = 0.014$) CVH scores (Table 4). After adding the composite fitness score to the model, the associations were non-significant. Higher levels of CRF were associated with higher global ($\beta = 0.55$, $P < 0.001$) and behavioural ($\beta = 0.74$, $P < 0.001$) CVH scores. After adding SB and MS to the model, the associations remained significant. Higher levels of MS were associated with higher global ($\beta = 0.43$, $P = 0.004$) and biological ($\beta = 0.40$, $P = 0.025$) CVH scores. After adding SB and CRF to the model, these results became nonsignificant. Higher composite fitness scores were associated with higher global ($\beta = 0.59$, $P < 0.001$) and behavioural ($\beta = 0.67$, $P < 0.001$) CVH scores. After adding SB to the model, both associations remained significant. When adding education and illness-related-factors to the models, all results remained unchanged, except for the association between MS and the ideal biological CVH score, which became non-significant (data not shown).

Discussion

Overall, the prevalence of ideal CVH metrics in patients with SMI was low. More than three-quarters of patients with complete data had sub-optimal CVH scores, with less than 5 of the 7 ideal CVH metrics, which is concerning because this score is associated with a higher risk of all-cause and cardiovascular mortality [3]. Additionally, although low SB, high CRF, and high MS levels are associated with meeting the ideal threshold in most CVH metrics and having higher global, behavioural, and biological CVH scores, only CRF remained significantly related to global CVH score, independent of SB and multiple confounders. These findings suggest that CRF has a stronger influence on CVH than SB or MS.

Taking into account that prevalence of ideal CVH metrics seems to vary by the country's socioeconomic status [3] due to sociocultural background and healthcare system differences, our prevalence data in patients with SMI were mainly compared to normative data from the healthy adult Spanish population [21]. The prevalence of ideal body mass index and physical activity among our population are lower and higher, respectively, than that among Spanish controls aged between 18 and 64 years [21], with the remaining metrics being practically similar, and healthy diet being the least prevalent. The poor levels of ideal body mass index and diet can be expected because overweight

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Table 2 Prevalence of American Heart Association ideal cardiovascular health metrics in patients with severe mental illness.

	Ideal health behaviours								Ideal biological measures					
	Non-smoking		Body mass index		Physical activity		Healthy diet		Blood pressure		Total cholesterol		Glucose	
	n[a]	% ideal (95% CI)	n[a]	% ideal (95% CI)	n[a]	% ideal (95% CI)	n[a]	% ideal (95% CI)	n[a]	% ideal (95% CI)	n[a]	% ideal (95% CI)	n[a]	% ideal (95% CI)
All	142	47.9 (39.8–56.1)	142	16.9 (11.6–23.9)	118	83.1 (75.3–88.8)	125	10.4 (6.2–17.0)	141	40.4 (32.7–48.7)	70	62.9 (51.1–73.2)	75	66.7 (55.4–76.3)
Gender														
Men	108	44.4 (35.4–53.8)	108	17.6 (11.6–25.8)	94	86.2 (77.8–91.7)	94	9.6 (5.1–17.2)	107	35.5 (27.1–44.9)	55	63.6 (50.4–75.1)	59	61.0 (48.3–72.4)
Women	34	58.8 (42.2–73.6)	34	14.7 (6.4–30.1)	24	70.8 (50.8–85.1)	31	12.9 (5.1–28.9)	34	55.9 (39.5–71.1)	15	60.0 (35.7–80.2)	16	87.5 (64.0–96.5)
P	0.143		0.695		0.123		0.735		0.035		0.796		0.046	
Age														
18–41 years	73	47.9 (36.9–59.2)	73	17.8 (10.7–28.1)	62	77.4 (65.6–86.0)	67	11.9 (6.2–21.8)	73	49.3 (38.2–60.5)	31	74.2 (56.8–86.3)	35	77.1 (61.0–87.9)
42–61 years	69	47.8 (36.5–59.4)	69	15.9 (9.1–26.3)	56	89.3 (78.5–95.0)	58	8.6 (3.7–18.6)	68	30.9 (21.2–42.6)	39	53.8 (38.6–68.4)	40	57.5 (42.2–71.5)
P	0.989		0.767		0.086		0.544		0.026		0.080		0.072	
Psychopathological severity[b]														
0–12	64	43.8 (32.3–55.9)	64	15.6 (8.7–26.4)	52	88.5 (77.0–94.6)	61	14.8 (8.0–25.7)	64	43.8 (32.3–55.9)	32	65.6 (48.3–79.6)	33	69.7 (52.7–82.6)
13–57	65	47.7 (36.0–59.6)	65	16.9 (9.7–27.8)	59	76.3 (64.0–85.3)	58	6.9 (2.7–16.4)	65	35.4 (24.9–47.5)	33	63.6 (46.6–77.8)	35	60.0 (43.6–74.4)
P	0.653		0.842		0.095		0.170		0.331		0.867		0.403	
Illness duration														
1–14 years	62	43.5 (31.9–55.9)	62	19.4 (11.4–30.9)	56	76.8 (64.2–85.9)	55	12.7 (6.3–24.0)	62	45.2 (33.4–57.5)	33	63.6 (46.6–77.8)	35	62.9 (46.3–76.8)
15–43 years	64	46.9 (35.2–58.9)	64	15.6 (8.7–26.4)	51	88.2 (76.6–94.5)	57	8.8 (3.8–18.9)	64	37.5 (26.7–49.7)	34	61.8 (45.0–76.1)	36	66.7 (50.3–79.8)
P	0.708		0.581		0.122		0.499		0.383		0.874		0.737	
Chlorpromazine equivalent dose														
0–450 mg/day	63	57.1 (44.9–68.6)	63	22.2 (13.7–33.9)	52	78.8 (66.0–87.8)	53	15.1 (7.9–27.1)	63	46.0 (34.3–58.2)	33	63.6 (46.6–77.8)	35	68.6 (52.0–81.4)
480–3000 mg/day	62	37.1 (26.2–49.5)	62	12.9 (6.7–23.4)	52	82.7 (70.3–90.6)	57	7.0 (2.8–16.7)	62	35.5 (24.7–47.9)	29	65.5 (47.3–80.1)	30	56.7 (39.2–72.6)
P	0.025		0.171		0.619		0.175		0.230		0.877		0.321	

NOTE. Chi square test was used to examine differences in the proportion of ideal CVH metrics, except to compare the proportion of ideal physical activity and diet between genders. Fisher's exact test was used in these two cases.

Significant when $P < 0.050$.

[a] n varies due to missing data. Reasons: Refusal to wear the SenseWear to assess physical activity (n = 8) and to undergo blood glucose and cholesterol determinations (n = 66); unregistered data attributed to technical problems to assess physical activity (n = 3), blood pressure (n = 1), and cholesterol (n = 6); unmet the SenseWear wear-time criteria to assess physical activity (n = 13); incomplete patient medical record data for illness duration and chlorpromazine equivalent dose (n = 16 and 17, respectively); and incomplete questionnaire data for psychopathological severity (n = 13).

[b] Psychopathological severity was assessed using the Brief Symptoms Inventory-18, with higher scores indicating greater severity.

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Table 3 Sedentary behaviour and fitness estimates by ideal cardiovascular health metrics in patients with severe mental illness.

	Sedentary behaviour (min/day)		6-min walk test (m)		Relative handgrip strength[a]		Composite fitness score[b]	
	N (%)	Values	N (%)	Values	N (%)	Values	N (%)	Values
Smoking								
Ideal	55 (47)	534 ± 144	67 (48)	612.6 ± 105.2	68 (48)	0.48 ± 0.12	67 (48)	0.01 ± 0.85
Non-ideal	63 (53)	534 ± 144	74 (52)	590.4 ± 99.4	74 (52)	0.51 ± 0.13	74 (52)	0.00 ± 0.90
P^c		0.999		0.075		0.549		0.381
Body mass index								
Ideal	18 (15)	414 ± 144	24 (17)	649.6 ± 113.6	24 (17)	0.62 ± 0.11	24 (17)	0.73 ± 0.85
Non-ideal	100 (85)	558 ± 132	117 (83)	591.0 ± 97.5	118 (83)	0.47 ± 0.12	117 (83)	−0.14 ± 0.81
P^c		<0.001		0.010		<0.001		<0.001
Physical activity								
Ideal	98 (83)	516 ± 138	98 (84)	615.1 ± 104.1	98 (83)	0.51 ± 0.13	98 (84)	0.15 ± 0.87
Non-ideal	20 (17)	624 ± 138	19 (16)	554.6 ± 72.0	20 (17)	0.44 ± 0.14	19 (16)	−0.40 ± 0.77
P^c		0.002		0.012		0.097		0.031
Diet								
Ideal	12 (11)	504 ± 96	13 (10)	644.2 ± 69.1	13 (10)	0.49 ± 0.10	13 (10)	0.19 ± 0.67
Non-ideal	93 (89)	546 ± 144	112 (90)	596.8 ± 105.1	112 (90)	0.49 ± 0.13	112 (90)	−0.02 ± 0.90
P^c		0.222		0.035		0.830		0.169
Blood pressure								
Ideal	51 (44)	498 ± 138	57 (41)	624.2 ± 97.4	57 (40)	0.53 ± 0.14	57 (41)	0.27 ± 0.93
Non-ideal	66 (56)	564 ± 144	83 (59)	586.8 ± 102.9	84 (60)	0.47 ± 0.11	83 (59)	−0.17 ± 0.80
P^c		0.006		0.003		<0.001		<0.001
Total cholesterol								
Ideal	40 (64)	480 ± 138	43 (62)	622.8 ± 84.9	44 (63)	0.52 ± 0.13	43 (62)	0.24 ± 0.78
Non-ideal	23 (36)	588 ± 132	26 (38)	592.2 ± 95.1	26 (37)	0.46 ± 0.11	26 (38)	−0.19 ± 0.78
P^c		0.005		0.245		0.037		0.032
Glucose								
Ideal	44 (66)	492 ± 132	50 (68)	604.6 ± 85.8	50 (67)	0.49 ± 0.14	50 (68)	0.02 ± 0.83
Non-ideal	23 (34)	576 ± 144	24 (32)	615.8 ± 96.2	25 (33)	0.51 ± 0.10	24 (32)	0.18 ± 0.69
P^c		0.010		0.848		0.749		0.915

NOTE. Values are the mean ± SD.
Significant when $P < 0.050$.
[a] Handgrip strength/body mass, both in kg.
[b] Constructed by averaging the standardized values of distance walked during the 6-min test and relative handgrip strength. Scores above zero represent higher fitness level.
[c] From analysis of covariance with gender and age as covariates.

and unhealthy diet are two well-known critical health issues in patients with SMI [22]. However, the rate of ideal physical activity (83.1%) was remarkably high compared to Spanish controls [21], which was based upon self-report measures and ranged from 33.7% to 49.4%, and with recent global data on self-reported (54.5%) and objective (57.0%) physical activity in patients with SMI [11]. This result may be because patients who agreed to participate are those who are aware of the importance of having an active lifestyle. Furthermore, although participants were asked to follow their usual lifestyle while wearing the activity monitor, and reactivity was minimized, our data were not exempt from influence by social desirability and reactivity. Nonetheless, while most patients were physically active, they were also highly sedentary (approximately 60% of waking hours), indicating that both physical activity and SB should be considered. Taking these findings together, developing optimal strategies for healthy eating, weight loss, and adopting a less sedentary lifestyle should be a major treatment focus to prevent or delay cardiovascular disease in patients with SMI.

According to the stratified groups, women most frequently had ideal blood pressure and glucose, and younger participants most commonly had ideal blood pressure, concurring with normative data from industrial and high-income Western European countries, such as Spain [21], France [23], and Italy [24]. However, the higher prevalence of ideal glucose in women seems to contradict global meta-analysis data [25], reporting that women with SMI had a higher risk for developing hyperglycaemia. One explanation for our findings may be because men had a higher systolic blood pressure than women (mean 125 vs. 115 mm Hg, respectively, $P = 0.023$; data not shown), a well-established predisposing factor for hyperglycaemia [26]. Finally, the higher smoking prevalence in patients with higher chlorpromazine equivalent dose may be explained, even when still controversial, by the postulation that smoking is a form of self-medication for the side effects of antipsychotics [27]. Altogether, younger, women, and those taking less antipsychotics seemed to have a better CVH profile among patients with SMI.

Because no study has accounted for SB and fitness simultaneously when exploring associations with ideal CVH, our results can be compared only with studies including one of the two exposures. At present, only two studies [6,7] have examined the association of ideal CVH

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Table 4 Standardized regression coefficients (β) of sedentary behaviour and fitness for cardiovascular health scores[a] among patients with severe mental illness (n = 54).

		Global CVH score		Behavioural CVH score[b]		Biological CVH score[c]	
		β	*P*	β	*P*	β	*P*
SB	M1	−0.41	0.002	−0.19	0.227	−0.37	0.014
	M1 + CFS[d]	−0.19	0.171	0.07	0.635	−0.31	0.062
CRF	M1	0.55	<0.001	0.74	<0.001	0.15	0.460
	M1 + SB + MS	0.45	0.002	0.78	<0.001	0.00	0.989
MS	M1	0.43	0.004	0.27	0.125	0.40	0.025
	M1 + SB + CRF	0.03	0.859	−0.15	0.370	0.24	0.280
CFS[d]	M1	0.59	<0.001	0.67	<0.001	0.37	0.067
	M1 + SB	0.48	0.003	0.70	<0.001	0.20	0.345

NOTE. M1 is adjusted for gender and age.
Abbreviations: CFS: composite fitness score; CRF: cardiorespiratory fitness; CVH: cardiovascular health; M1: model 1; MS: muscular strength; SB: sedentary behaviour.
Significant when $P < 0.050$.
[a] According to American Heart Association criteria, the global (ranging from 0 to 7), behavioural (0–4), and biological (0–3) cardiovascular health scores were computed as the sum of the metrics, in which the ideal threshold was met (i.e., 1 point for each).
[b] Adjusted for status (ideal/non-ideal) of blood pressure, total cholesterol, and glucose.
[c] Adjusted for status (ideal/non-ideal) of smoking, body mass index, physical activity, and diet.
[d] Constructed by averaging the standardized values of CRF (measured as distance walked during the 6-min test) and MS (measured as handgrip strength/body mass). Scores above zero represent a higher fitness level.

and SB—one [6] in adolescents and the other [7] in the general adult population with similar age as our participants—using self-reported SB in both cases, and three studies [8–10] have examined the association of ideal CVH and fitness—one [9] in children and adolescents (using MS assessed by handgrip dynamometry), another [8] in adolescents (using CRF assessed by the 20-m shuttle-run test), and the remaining [10] in older community-dwelling adults (using global and individual scores of the Short Physical Performance Battery tests: walking speed, leg strength, and standing balance). Despite the different measurement methods and age samples used in the aforementioned studies, low SB and high fitness levels were separately related to a favourable CVH profile, which is in agreement with our results.

Finally, our results suggest that fitness remains related to global CVH score independently of SB, possibly because fitness seems to be a stronger and more-informative CVH factor than lifestyle behaviours, such as physical activity and SB in patients with SMI [14] and in the general population [5]. Although we showed that the association between MS and global CVH score became non-significant after adjusting for CRF, healthcare system should include a focus on improving both MS and CRF to reduce all-cause and cardiovascular mortality, as has been recently and consistently reported in a prospective study of >1.5 million adults [28].

This study presents some novelties and strengths. This is the first study to explore ideal CVH in patients with SMI and to examine the independent association of SB and fitness with CVH score. The main strength is the strict criteria for measuring physical activity and SB. All patients wore the activity monitor for seven consecutive days for at least 1368 min/day (95% of a 24-h period) of registered time, and reactivity was minimized. To the best of our knowledge, only four studies [8,29–31] on ideal CVH, of which two [29,30] were conducted on adults, have objectively measured physical activity, and none have objectively measured SB. Limitations include the relatively small convenience sample of outpatients, predominantly men diagnosed with schizophrenia, whose sample size varied due to missing data about the CVH metrics (specified in Table 1). Only 54 (38%) of the 142 participants had complete ideal CVH data, which may introduce bias; however, no significant differences were found between those who had complete ideal CVH data and those who had missing components in age, gender, and illness-related factors, sedentary behaviour, CRF, and MS (data not shown). These limitations may affect the generalizability of the study results. The cross-sectional design precludes causal relationships. Although the absence of a control group can be considered a limitation, we compared our data against healthy adult normative data from Spain and other similar European countries and against all published studies that have examined the association of SB and fitness with CVH score, each of which is based on observations from hundreds of healthy individuals. Nevertheless, studies including a control group are required to confirm or refute our findings. SB may have included standing, as the SenseWear cannot determine posture. However, despite including a biaxial-accelerometer, it may resolve limitations presented by triaxial-accelerometers and inclinometers through heat production measurements and placement on the upper arm. The SB measurement did not allow examining the associations of specific SBs, such as television viewing, with ideal CVH in patients with SMI, and research utilizing appropriate questionnaires [32] is needed. Although the 6-min walk test is of limited utility for individual patients, it can be used to accurately estimate mean peak oxygen uptake, the gold standard for assessing CRF, among groups of deconditioned patients [33] such as patients with SMI [12]. The handgrip test characterizes only upper-limb MS, and future studies should consider lower-limb MS and the

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combination of both to characterize overall MS. Finally, the composite fitness score is sample-specific and based on the assumption that each fitness parameter is weighted equally.

In conclusion, patients with SMI generally have a low prevalence of ideal CVH metrics, especially for diet and body mass index, and a low global CVH score, both being associated with high SB and low CRF and MS. Our study further found that higher CRF levels were directly related to a higher CVH score independently of SB, MS and multiple confounders. Altogether, we suggest that adults with SMI would benefit less from strategies directed only at reducing SB in terms of CVH. Longitudinal studies, especially interventions with well-sampled randomized controlled trials investigating changes in SB, CRF, and MS measured objectively, are necessary to gain better insights into their interrelationships with ideal CVH.

Declarations of interest

None.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.numecd.2018.05.003.

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Supplemental material 1. Standardized regression coefficients (β) without adjusting for the status (ideal or non-ideal) of the rest metrics when exploring the role of the behavioural and biological CVH scores.

		Global CVH score		Behavioural CVH score		Biological CVH score	
		β	*P*	β	*P*	β	*P*
SB	M1	-0.41	0.002	-0.22	0.117	-0.39	0.004
	M1+ CFS[†]	-0.19	0.171	0.07	0.607	-0.31	0.041
CRF	M1	0.55	<0.001	0.71	<0.001	0.21	0.156
	M1+ SB + MS	0.45	0.002	0.75	<0.001	0.05	0.748
MS	M1	0.43	0.004	0.29	0.063	0.37	0.012
	M1 + SB + CRF	0.03	0.859	-0.15	0.354	0.16	0.424
CFS[†]	M1	0.59	<0.001	0.60	<0.001	0.34	0.023
	M1+ SB	0.48	0.003	0.64	<0.001	0.17	0.312

NOTE. M1 is adjusted for gender and age.

Abbreviations: CFS: composite fitness score; CRF: cardiorespiratory fitness; CVH: cardiovascular health; M1: model 1; MS: muscular strength; SB: sedentary behaviour.

[*]According to American Heart Association criteria, the global (ranging from 0 to 7), behavioural (0-4), and biological (0-3) cardiovascular health scores were computed as the sum of the metrics in which the ideal threshold was met (i.e., 1 point for each).

[†]Constructed by averaging the standardized values of CRF (measured as distance walked during the 6-minute test) and MS (measured as handgrip strength/body mass). Scores above zero represent higher fitness level.

Significant when $P < 0.050$.

ESTUDIO 3 [STUDY 3]

Sedentary behaviour, physical activity, cardiorespiratory fitness and cardiometabolic risk in psychosis: The PsychiActive project.

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Sedentary behaviour, physical activity, cardiorespiratory fitness and cardiometabolic risk in psychosis: The PsychiActive project

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A B S T R A C T

This study aimed to explore the possible independent associations of sedentary behaviour (SB), physical activity (PA), and cardiorespiratory fitness (CRF) with clustered (CCRS) and individual cardiometabolic risk (waist circumference [waist], systolic/diastolic blood pressure, triglycerides, high-density lipoprotein-cholesterol, and fasting blood glucose) in patients with psychosis. In 43 outpatients with psychosis (mean age ± SD: 42.3 ± 8.5 years, 86% men), SB and light, moderate-to-vigorous, and total PA were measured with the SenseWear Pro3 Armband, and CRF with the 6-minute walking test. Multiple linear regression models adjusted for multiple confounders were applied. High SB, low PA and low CRF levels were associated with an unfavourable cardiometabolic risk profile (increased presence of metabolic syndrome and number of cardiometabolic abnormalities, as well as worse values and elevated presence of abnormalities for all individual cardiometabolic risk factors). SB was associated with CCRS, number of cardiometabolic abnormalities, waist, and fasting blood glucose (all $p < 0.05$). After adjusting for PA and CRF, waist and fasting blood glucose remained significant. Light PA was associated with waist, moderate-to-vigorous PA with CCRS, and total PA with CCRS and waist (all $p < 0.05$). These results became non-significant after adjusting for SB and CRF. CRF was associated with CCRS, waist, and systolic blood pressure (all $p < 0.05$). The associations with CCRS and waist remained significant after adjusting for SB and PA. Together, these results suggest the importance of considering SB and CRF, regardless PA, in the prevention and treatment of cardiometabolic disorders among patients with psychosis.

1. Introduction

Patients with psychosis, including schizophrenia and bipolar disorders (World Health Organization, 1992), have a greatly reduced life expectancy, up to 15 years, compared to the general population (Lawrence et al., 2013), with cardiometabolic disease being the main contributor (Correll et al., 2017). The increased prevalence of metabolic syndrome and cardiometabolic abnormalities is also evident (Vancampfort et al., 2015b), and has become a major health challenge. Of concern, a recent study (Bruins et al., 2017) revealed that cardiometabolic risk factors remain seriously undertreated in people with psychosis and, therefore, better prevention and treatment of metabolic disorders are imperative for reducing the overwhelming risk of premature mortality.

In general population, there is an established-evidence base indicating that, independently, less sedentary behaviour (SB) and greater physical activity (PA) decrease cardiometabolic risk (Biswas et al., 2015). Two meta-analyses (Stubbs et al., 2016a; Stubbs et al., 2016b) highlighted that patients with psychosis engage in more SB and in less PA than the general population. To date, some studies (e.g., (Nyboe et al., 2015; Stubbs et al., 2015; Vancampfort et al., 2015a)) have suggested associations of SB and PA with cardiometabolic risk in patients with psychosis. While helpful, almost all of these studies have relied upon self-report measures, which introduce bias (Soundy et al., 2014), and only one study examined the independent associations of SB and PA with cardiometabolic risk (Stubbs et al., 2017). In this regard, more research, as well as the preferential use of objective measures, is necessary to improve our understanding of the independent effects of these two exposures on cardiometabolic health in this population.

There is also a firmly established-base indicating that a low cardiorespiratory fitness (CRF) level is a strong independent predictor of all-cause and cardiovascular mortality (Harber et al., 2017), with two recent studies (Knaeps et al., 2016a; Knaeps et al., 2016b) finding that CRF mediates the association of SB and PA with clustered-cardiometabolic risk and its individual-components. Patients with psychosis have significantly lower CRF compared with controls (Vancampfort et al., 2017), and the independent associations of SB, PA, and CRF with clustered-cardiometabolic risk and individual-cardiometabolic risk factors remain unexplored.

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The aim of this study was to explore the possible independent associations of SB, PA, and CRF with clustered-cardiometabolic risk and individual-cardiometabolic risk factors in patients with psychosis (schizophrenia and bipolar disorders).

2. Methods

2.1. Participants and setting

Adults with a diagnosis of psychotic illness including schizophrenia and bipolar disorders according to ICD-10 criteria and stabilized on antipsychotic medication was recruited from 11 different outpatient mental healthcare settings in southern Spain. Patients were excluded if they had clinical instability, co-morbid substance abuse, or evidence of uncontrolled cardiovascular, neuromuscular and endocrine disorders. Participants received a full-fasting laboratory screening and anthropometric measurement, performed a walk test, wore a multisensor armband, and completed questionnaires about sociodemographic characteristics and symptomatology. Patient's medical records were also registered. The study procedure was approved by the Universidad Pablo de Olavide Ethics Committee. All patients gave their informed written consent prior to enrolling in the study and after receiving information about the aims and protocol. There was no compensation for participation.

2.2. SB and PA

SB and PA were obtained with a SenseWear Pro3 Armband (BodyMedia Inc., Pittsburgh, PA, USA), a device to accurately estimate energy expenditure (Johannsen et al., 2010). Patients were required to wear the SenseWear on their left arm triceps muscle for nine consecutive days, 24 h/day, except when showering or swimming. The first and last days were excluded from the analysis to minimize the Hawthorne effect (i.e., "a general scientific fact that the process of observation alters the phenomenon being observed") (Corder et al., 2008). Seven days of recordings with a minimum of 1368 min of registration per day was necessary to be included in the analysis. Energy expenditure was estimated using data recorded from multiple sensors and using specific-algorithms developed by the manufacturer (SenseWear Professional software, version 8.1). Time spent in SB ($1.0 < MET \leq 1.5$) and PA intensities (light, $1.5 < MET \leq 3.0$; moderate-to-vigorous, >3.0 MET; and total >1.5 MET) was derived using the measured MET values during waking hours.

2.3. CRF

CRF was assessed using the 6-minute walking test according to Rikli and Jones (1999) in an indoor course with a flat, firm surface and with minimal external stimuli. Patients were instructed to walk as far as possible during a 6-minute period around a 45.7-meter rectangular course delimited by cones, without running or jogging. Resting was allowed if necessary, but walking was to be resumed as soon as possible. Standardized-encouragements were used at recommended intervals (Rikli and Jones, 1999). The same trained instructor explained the protocol, gave a demonstration prior to the start, supervised the test and recorded the total distance walked to the nearest 0.1 m for each patient. The 6-minute walking test has been shown to be a reliable and valid method to assess CRF in patients with psychosis (Gomes et al., 2016).

2.4. Cardiometabolic risk

The cardiometabolic risk factors were collected by trained-staff in the morning after an overnight fast including waist circumference (waist), systolic/diastolic blood pressure, triglycerides, high-density lipoprotein-cholesterol, and fasting blood glucose. Waist was measured to the nearest 0.1 cm using a measuring tape (Harpenden Anthropometric Tape; Holtain, Dyfed, UK) placed at the midpoint between the last rib and the iliac crest. Blood pressure was measured in a seated position after 10-minute rest period with an electronic monitor (Omron Healthcare Europe BV, Hoofddorp, The Netherlands) placed on the left arm wrist. The mean of the two measures was used for analysis. If the two measures differed by >1% for waist, >20 mm Hg for systolic and >10 mm Hg for diastolic blood pressure, a third measure was taken, and the median of the three was used for analysis (Ward and Anderson, 1998). The presence of metabolic syndrome and cardiometabolic abnormalities was assessed using the International Diabetes Federation criteria (Alberti et al., 2006). Additionally, a clustered-cardiometabolic risk score (CCRS) was constructed. The standardized-normalized indexes (z-score = [value − mean] / standard deviation) for blood pressure ([systolic + diastolic blood pressure] / 2), triglycerides, fasting blood glucose, waist, and the inverse of high-density lipoprotein cholesterol were summarized and divided by the number of variables included ($x = 5$) to generate the CCRS. Scores above zero represent higher cardiometabolic risk.

2.5. Severity of psychiatric symptoms

Severity of psychiatric symptoms during the previous week was assessed using the Brief Symptoms Inventory-18 (Derogatis, 2001), which has been recommended in patients with mental illness (Prinz et al., 2013). Scores range 0–72, with higher scores indicating a higher severity.

2.6. Demographic, illness-related, and medication data

Marital, educational, occupational and smoking status were self-reported. Weight and height were measured with to the nearest 0.1 kg and 0.1 cm using a scale (TANITA BC-420; Tanita, Tokyo, Japan) and stadiometer, respectively, and body mass index was calculated. Age, diagnosis, illness duration, and medication were retrieved from the patients' medical records, and antipsychotic medication was converted into daily equivalent dosages of chlorpromazine (Gardner et al., 2010).

2.7. Statistical analysis

Due to the skewed distributions, the analyses included the logarithmically transformed data of moderate-to-vigorous PA, triglycerides, and illness duration, as well as the reciprocally transformed data of fasting blood glucose and the square root-transformed data of chlorpromazine and severity of psychiatric symptoms. Differences in SB, PA, and CRF between metabolic syndrome presence were tested using Student's *t*-test. Patients were divided into groups according to high or low levels of SB, PA (light, moderate-to-vigorous and total), and CRF using the median splits, while Student's t, Chi-square, and Fisher exact tests were applied to establish differences. Pearson correlation coefficients were calculated between SB, PA, CRF, and cardiometabolic risk. Multiple linear regression analyses were performed with the cardiometabolic risk outcomes as dependent variables and SB, PA, and CRF as the independent variables. Model-1 was adjusted for gender, age, smoking, education, severity of psychiatric symptoms, illness duration, and chlorpromazine dose. Waist was added in Model-2. Additionally, SB, PA, and CRF, as applicable, were added in the fully adjusted models. Only patients with a complete dataset were included in the regression analysis. Residuals were tested for homoscedasticity, linearity and independence. Other than when light and total PA were simultaneously used as independent variables, the variance inflation factor never exceeded five, indicating that multi-collinearity was not a concern (Montgomery et al., 2012). The data were analysed using SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp), with statistical significance set at $p\text{-value} < 0.05$. Statistical comparisons between the two psychiatric groups were not carried out because the small sample size for bipolar disorders ($n = 11$) data could have led to type II statistical errors.

3. Results

Forty-three patients with psychosis were included in the analysis, and characteristics are summarized in Table 1. Within the sample, 28 patients (65.2%) met the criteria for metabolic syndrome. Those with metabolic syndrome were significantly more sedentary, less physically active (for all PA variables), and had lower CRF than those without metabolic syndrome (all $p < 0.05$; data not shown). As presented in Table 2, the high SB, low PA (all variables) and CRF groups exhibited a higher presence of metabolic syndrome and number of cardiometabolic abnormalities than their counterparts, yet not reaching statistical significance except when comparing light PA levels (both $p < 0.05$). Furthermore, worse values and a higher presence of abnormalities for all individual-cardiometabolic risk factors were found in the high SB and low light PA, moderate-to-vigorous PA, and CRF groups compared with their counterparts; however, significance was only indicated in diastolic blood pressure between SB levels and in waist and triglycerides between light PA levels (all $p < 0.05$). The low total PA group had a significantly higher waist than the high total PA group ($p = 0.025$). Additionally, a heightened CCRS was found in the high SB, and low PA (all variables) and CRF groups, albeit significant only when comparing light and total PA levels (both $p < 0.05$; data not shown).

Correlations between SB, PA, CRF, and cardiometabolic risk are presented in Table 3. SB had a significant negative correlation with all PA variables and CRF (all $p < 0.05$). Furthermore, moderate-to-vigorous and total PA had a significant moderate positive correlation with CRF (both $p < 0.05$). The CCRS and the number of cardiometabolic abnormalities were positively associated with SB and negatively associated with light PA, total PA, and CRF (all $p < 0.05$). In general, significant correlations with individual-cardiometabolic risk factors were fair to moderate, ranging from 0.30 to 0.57, expressed in absolute terms (Table 3).

Due to missing data, a subsample of 38 patients (32 men and 11 with bipolar disorders) with no changes in the correlation coefficients of the significant correlates (all $p < 0.05$; data not shown) was included in the multiple regression analysis (Table 4). SB was associated with the CCRS ($\beta = 0.28$, $p = 0.049$), the number of cardiometabolic abnormalities ($\beta = 0.33$, $p = 0.023$), waist ($\beta = 0.45$, $p = 0.001$), and fasting blood glucose ($\beta = 0.38$, $p = 0.023$) (Model-1). The associations with the CCRS and the number of cardiometabolic abnormalities became non-significant after adjustment for the combined PA and CRF. A significant association for waist remained after adjusting for moderate-to-vigorous PA and CRF. Furthermore, the association with fasting blood glucose remained significant after adjusting for all PA variables, in separate fully adjusted models, and for CRF. Light PA was associated with waist ($\beta = 0.40$, $p = 0.005$) (Model-1). The association attenuated to non-significance after adjusting for SB, moderate-to-vigorous PA, and CRF. Moderate-to-vigorous PA was associated with the CCRS ($\beta = -0.30$, $p = 0.043$) (Model-1). The association moved beyond the threshold of significance after adjusting for SB, PA (light and total PA, in separate fully adjusted models), and CRF. Total PA was associated with the CCRS ($\beta = -0.32$, $p = 0.024$) and waist ($\beta = -0.38$, $p = 0.008$) (Model-1). These results became non-significant after adjust for SB, moderate-to-vigorous PA, and CRF. CRF was significantly associated with the CCRS ($\beta = -0.42$, $p = 0.026$) (Model 2), waist ($\beta = -0.55$, $p = 0.001$), and systolic blood pressure ($\beta = -0.45$, $p = 0.028$) (Model-1). The associations with the CCRS and waist remained after adjusting for SB and all PA variables (in separate fully adjusted models) (Table 4).

Table 1
Patients' characteristics ($n = 43$).

Variables	Values
Age (years)	42.3 ± 8.5
Body mass index (kg/m^2)	30.5 ± 5.5
SB (h/day, % of waking time)	8.8 ± 2.1 (59)
LPA (h/day, % of waking time)	4.3 ± 1.6 (28)
MVPA (h/day, % of waking time)	1.9 ± 1.2 (13)
TPA (h/day, % of waking time)	6.2 ± 2.3 (41)
CRF (m)	598.7 ± 94.6
MetS[a]	28 (65.1)
No. of meeting MetS[a]	2.8 ± 1.7
Waist (cm)	105.6 ± 16.5
IDF criteria	36 (83.7)
SBP (mm Hg)	126.3 ± 17.8
IDF criteria	21 (48.8)
DBP (mm Hg)	82.4 ± 11.0
IDF criteria	20 (46.5)
TG (mg/dL)	210.5 ± 177.0
IDF criteria	25 (58.1)
HDL-C (mg/dL)	44.4 ± 11.8
IDF criteria	21 (48.8)
FBG (mg/dL)	106.9 ± 38.8
IDF criteria	20 (46.5)
Severity of psychiatric symptoms (0–72)[b, c]	14.7 ± 11.6
Illness duration (years)[b]	16.2 ± 9.3
Chlorpromazine equivalent dose (mg/day)[b]	643.7 ± 576.2
Smoking status (current smoker)	25 (58.1)
Gender (women)	6 (14.0)
Race (Caucasian)	43 (100)
Diagnoses	
Schizophrenia spectrum disorders	32 (74.4)
Bipolar disorders	11 (25.6)
Marital status	
Married	6 (14.0)
Unmarried	32 (74.4)
Separated/divorced	5 (11.6)
Educational status[b]	
Unfinished secondary school	20 (47.6)
Finished secondary school	22 (52.4)
Occupational status[b]	
Working	13 (31.0)
Unemployed	10 (23.8)
Retired	19 (45.2)

Note: Values are in mean ± SD or n (%). SB, LPA, MVPA, and TPA are for an average day. CRF: cardiorespiratory fitness; DBP: diastolic blood pressure; FBG: fasting blood glucose; HDL-C: high-density lipoprotein cholesterol; IDF: International Diabetes Federation; LPA: light physical activity; MetS: metabolic syndrome; MVPA: moderate-to-vigorous physical activity; SB: sedentary behaviour; SBP: systolic blood pressure; TG: triglycerides; TPA: total physical activity, Waist: waist circumference.

[a] According to the International Diabetes Federation criteria.

[b] Missing data. Reasons: Incomplete patient medical record data for illness duration and chlorpromazine equivalent dose ($n = 1$ and 3, respectively); incomplete questionnaire data for severity of psychiatric symptoms, educational and occupational status (all $n = 1$).

[c] Severity of psychiatric symptoms was assessed using the Brief Symptoms Inventory-18; with higher scores indicating high severity of psychiatric symptoms.

4. Discussion

This is one of the few studies (Ekblom et al., 2015; Greer et al., 2015; Knaeps et al., 2016a; Knaeps et al., 2016b; Shuval et al., 2014; van der Velde et al., 2015) to evaluate the independent associations of SB, PA, and CRF with cardiometabolic risk, and the first to focus on patients with psychosis. The main result suggests that although high levels of SB and low levels of PA and CRF are associated with a higher clustered-cardiometabolic risk, only CRF remains significantly related independent of multiple confounders (including SB and PA). Additionally, when examining independently the single cardiometabolic risk factors, CRF and SB are associated with waist and SB with fasting blood glucose, and all of these associations are independent of the other potential exposures. Taken together, these results suggest the importance of considering CRF and SB, regardless of PA, in the prevention and treatment of metabolic disorders among patients with psychosis.

Our results showed the independent association between CRF and clustered-cardiometabolic risk consistent with aforementioned similar studies (Ekblom et al., 2015; Greer et al., 2015; Knaeps et al., 2016a; Knaeps et al., 2016b; Shuval et al., 2014; van der Velde et al., 2015), including three (Ekblom et al., 2015; Knaeps et al., 2016b; van der Velde

Table 2
Comparison of cardiometabolic characteristics between levels of ST, PA, and CRF among outpatients with psychosis ($n = 43$).

	SB (cut-off: 8.8 h/day)		LPA (cut-off: 4.7 h/day)		MVPA (cut-off: 1.7 h/day)		TPA (cut-off: 6.3 h/day)		CRF (cut-off: 607.2 m)	
	High ($n = 21$)	Low ($n = 22$)	Low ($n = 21$)	High ($n = 22$)	Low ($n = 21$)	High ($n = 22$)	Low ($n = 21$)	High ($n = 22$)	Low ($n = 21$)	High ($n = 22$)
MetS[a]	16 (76.2)	12 (54.5)	17 (81.0)	**11 (50.0)**	15 (71.4)	13 (59.1)	16 (76.2)	12 (54.5)	16 (76.2)	12 (54.5)
No. of meeting MetS[a]	3.3 ± 1.7	2.4 ± 1.7	3.4 ± 1.4	**2.3 ± 1.8**	3.2 ± 1.7	2.5 ± 1.7	3.1 ± 1.7	2.5 ± 1.8	3.2 ± 1.7	2.5 ± 1.7
Waist (cm)	110.3 ± 18.0	101.2 ± 14.0	113.2 ± 12.6	**98.4 ± 16.8**	106.4 ± 17.6	104.8 ± 15.8	111.3 ± 15.2	**100.1 ± 16.2**	109.4 ± 18.5	102.0 ± 13.8
IDF-criteria	19 (90.5)	17 (77.3)	21 (100.0)	**15 (68.2)**	19 (90.5)	17 (77.3)	20 (95.2)	16 (72.7)	19 (90.5)	17 (77.3)
SBP (mm Hg)	130.3 ± 18.0	122.5 ± 17.2	127.9 ± 17.7	124.8 ± 18.2	127.7 ± 19.5	125.0 ± 16.4	131.3 ± 17.7	121.5 ± 16.9	131.2 ± 17.6	121.6 ± 17.1
IDF-criteria	12 (57.1)	9 (40.9)	11 (52.4)	10 (45.5)	12 (57.1)	9 (40.9)	13 (61.9)	8 (36.4)	13 (61.9)	8 (36.4)
DBP (mm Hg)	85.8 ± 11.6	**79.1 ± 9.6**	83.7 ± 11.9	81.2 ± 10.3	83.8 ± 12.3	81.1 ± 9.7	85.7 ± 11.0	79.2 ± 10.3	85.2 ± 11.5	79.7 ± 10.1
IDF-criteria	13 (61.9)	**7 (31.8)**	9 (42.9)	11 (50.0)	12 (57.1)	8 (36.4)	11 (52.4)	9 (40.9)	11 (52.4)	9 (40.9)
TG (mg/dL)	231.3 ± 196.6	190.6 ± 158.1	215.4 ± 102.9	205.7 ± 228.6	233.5 ± 198.5	188.5 ± 155.3	208.7 ± 101.3	212.2 ± 230.0	209.7 ± 144.7	211.3 ± 206.7
IDF-criteria	15 (71.4)	10 (45.5)	16 (76.2)	**9 (40.9)**	15 (71.4)	10 (45.5)	15 (71.4)	10 (45.5)	15 (71.4)	10 (45.5)
HDL-C (mg/dL)	43.0 ± 12.8	45.7 ± 11.0	41.3 ± 9.9	47.3 ± 13.0	44.2 ± 13.7	44.6 ± 10.1	42.4 ± 12.1	46.3 ± 11.6	43.7 ± 11.7	45.1 ± 12.2
IDF-criteria	10 (47.6)	11 (50.0)	11 (52.4)	10 (45.5)	11 (52.4)	10 (45.5)	11 (52.4)	10 (45.5)	11 (52.4)	10 (45.5)
FBG (mg/dL)	117.0 ± 51.2	97.2 ± 17.8	110.7 ± 527.2	103.2 ± 38.1	113.9 ± 51.7	100.2 ± 19.4	106.7 ± 40.8	107.0 ± 37.9	112.4 ± 41.9	101.5 ± 35.9
IDF-criteria	12 (57.1)	8 (36.4)	11 (52.4)	9 (40.9)	11 (52.4)	9 (40.9)	9 (42.9)	11 (50.0)	11 (52.4)	9 (40.9)

Notes: The sample was divided into low and high levels of SB, LPA, MVPA, TPA, and CRF using the median splits. Analyses were conducted with TG logarithmically transformed and FBG reciprocally transformed to obtain a normal distribution, yet crude values are presented in the table for easier interpretation. Values are in mean ± SD or n (%). SB, LPA, MVPA, and TPA are for an average day.
CRF: cardiorespiratory fitness; DBP: diastolic blood pressure; FBG: fasting blood glucose; HDL—C: high-density lipoprotein cholesterol; IDF: International Diabetes Federation; LPA: light physical activity; MetS: metabolic syndrome; MVPA: moderate-to-vigorous physical activity; SB: sedentary behaviour; SBP: systolic blood pressure; TG: triglycerides; TPA: total physical activity, Waist: waist circumference.
Boldface indicates statistical significance (p-value < 0.05).
[a] According to the International Diabetes Federation-criteria.

et al., 2015) that objectively measured SB and PA and two (Knaeps et al., 2016a; Knaeps et al., 2016b) that used a clustering of individual-cardiometabolic risk factors in the same individual that might reflect cardiometabolic risk even better than single independent risk factors, as well as the number of cardiometabolic abnormalities and metabolic syndrome (Wijndaele et al., 2006). Our results in patients with psychosis indicated that, together with the lack of association of SB and PA, CRF is the most important exposure for cardiometabolic risk, concurring with the findings of the two studies that used the CCRS (Knaeps et al., 2016a; Knaeps et al., 2016b). An explanation may be because CRF reflects both participation in sedentary and physical activities and the state of physiological systems, thereby providing more information about health status. Moreover, each 5-mL·kg^{-1}·min^{-1} decrement in peak oxygen uptake (the criterion measure of CRF) corresponds to 56% higher prevalence of cardiovascular risk factors (Aspenes et al., 2011), being a deficient CRF one of the main cardiovascular mortality risk factors (Harber et al., 2017). These findings are of clinical interest, and, consistent with strongly supported evidence (Ross et al., 2016), highlight that CRF must be considered as a vital sign in clinical practice and in public health.

No study has accounted for SB, PA, and CRF simultaneously in patients with psychosis, and consequently, our results can be compared only with studies including two of the three exposures. Consistent findings in patients with psychosis reported that only CRF, and not PA, was significantly correlated with clustered-cardiometabolic risk (metabolic syndrome) (Nyboe et al., 2015). In another study (Stubbs et al., 2015), it was found that SB, and not PA, was associated with high-sensitivity C-reactive protein level, an inflammatory-marker associated with metabolic syndrome (Kazemi-Bajestani et al., 2017). Although similar findings, the two aforementioned studies (Nyboe et al., 2015; Stubbs et al., 2015) were based on self-reported measures of SB and PA, and consequently, direct comparisons with our results may not be valid. Therefore, in addition to examining the relationship of SB, PA and CRF together for predicting clustered-cardiometabolic risk, our work contributes to the knowledge by objectively measuring behaviour.

Table 3
Pearson correlation coefficients (r) for the association between SB, PA, CRF, and cardiometabolic risk among outpatients with psychosis ($n = 43$).

	SB		LPA		MVPA		TPA		CRF	
	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value
CCRS	0.43	**0.004**	−0.45	**0.002**	−0.27	0.084	−0.39	**0.009**	−0.45	**0.003**
No. of meeting MetS[a]	0.38	**0.012**	−0.41	**0.006**	−0.23	0.130	−0.40	**0.004**	−0.35	**0.021**
Waist	0.51	**0.001**	−0.57	**<0.001**	−0.25	0.111	−0.47	**<0.001**	−0.34	**0.025**
SBP	0.34	**0.026**	−0.25	0.101	−0.17	0.280	−0.24	0.060	−0.38	**0.012**
DBP	0.34	**0.026**	−0.28	0.066	−0.08	0.618	−0.24	0.061	−0.25	0.099
TG	−0.18	0.258	0.24	0.123	0.17	0.277	0.25	0.051	0.17	0.270
HDL-C	0.20	0.203	−0.20	0.188	−0.21	0.182	−0.30	**0.025**	−0.26	0.088
FBG	0.39	**0.010**	−0.10	0.522	0.06	0.722	−0.24	0.120	−0.07	0.677
SB	1.00	–	−0.60	**<0.001**	−0.55	**<0.001**	−0.67	**<0.001**	−0.37	**0.014**
LPA	−0.60	<0.001	1.00	–	0.45	0.003	0.88	<0.001	0.24	0.126
MVPA	−0.55	<0.001	0.45	0.003	1.00	–	0.78	<0.001	0.53	<0.001
TPA	−0.67	**<0.001**	0.88	**<0.001**	0.78	**<0.001**	1.00	–	0.47	**0.001**
CRF	−0.37	**0.014**	0.24	0.126	0.53	**<0.001**	0.47	**<0.001**	1.00	–

Notes: Analyses were conducted with MVPA and TG logarithmically transformed, and FBG reciprocally transformed, to obtain a normal distribution.
CCRS: clustered-cardiometabolic risk score; CRF: cardiorespiratory fitness; DBP: diastolic blood pressure; FBG: fasting blood glucose; HDL-C: high-density lipoprotein; LPA: light physical activity; MetS: metabolic syndrome; MVPA: moderate-to-vigorous physical activity; SB: sedentary behaviour; SBP: systolic blood pressure; TG: triglycerides; TPA: total physical activity, Waist: waist circumference.
Boldface indicates statistical significance (p-value < 0.05).
[a] According to the International Diabetes Federation-criteria (cita).

Table 4
Standardized regression coefficients (β) of SB, PA, and CRF for cardiometabolic risk among patients with psychosis ($n = 38$).

		CCRS		No. of meeting MetS[a]		Waist (cm)		SBP (mm Hg)		DBP (mm Hg)		TG (mg/dL)		HDL-C (mg/dL)		FBG (mg/dL)	
		β	p-Value	β	p-Value	β	p-Value	β	p-Value	β	p-Value	β	p-Value	β	p-Value	β	p-Value
SB	M1	0.28	**0.049**	0.33	**0.023**	0.45	**0.001**	0.26	0.128	0.29	0.090	0.20	0.198	−0.16	0.297	0.38	**0.023**
	M2							0.01	0.967	−0.01	0.945	0.24	0.202	−0.09	0.642	0.44	**0.032**
	M2 + LPA	0.34	**0.042**	0.29	0.108	0.34	**0.038**	0.01	0.960	−0.01	0.979	0.30	0.159	−0.11	0.595	0.59	**0.010**
	M2 + MVPA	0.22	0.104	0.35	0.072	0.48	**0.007**	0.01	0.953	0.06	0.805	0.16	0.495	0.05	0.824	0.77	**0.002**
	M2 + TPA	0.30	0.099	0.31	0.128	0.38	**0.040**	0.04	0.864	0.01	0.966	0.20	0.397	−0.02	0.921	0.71	**0.005**
	M2 + CRF	0.19	0.124	0.28	0.086	0.31	**0.026**	−0.04	0.848	−0.02	0.895	0.21	0.278	−0.04	0.845	0.43	**0.045**
	M2 + LPA + CRF	0.22	0.179	0.26	0.189	0.22	0.161	−0.03	0.888	−0.02	0.936	0.28	0.212	−0.07	0.757	0.58	**0.015**
	M2 + MVPA + CRF	0.19	0.147	0.32	0.107	0.40	**0.016**	0.02	0.938	0.06	0.801	0.16	0.498	0.05	0.836	0.77	**0.002**
	M2 + TPA + CRF	0.24	0.166	0.29	0.164	0.32	0.069	0.04	0.880	0.01	0.971	0.20	0.409	−0.02	0.935	0.71	**0.005**
LPA	M1	−0.26	0.063	−0.24	0.109	−0.40	**0.005**	−0.22	0.197	−0.25	0.150	−0.03	0.836	0.09	0.585	−0.03	0.851
	M2							0.00	0.994	0.02	0.922	0.00	0.983	−0.01	0.977	0.05	0.797
	M2 + SB	−0.05	0.758	−0.06	0.745	−0.19	0.230	0.01	0.976	0.01	0.942	0.13	0.517	−0.06	0.784	0.32	0.134
	M2 + MVPA	−0.15	0.381	−0.18	0.316	−0.36	**0.035**	0.00	0.998	−0.03	0.886	0.14	0.498	−0.13	0.513	0.02	0.933
	M2 + CRF	−0.12	0.356	−0.18	0.268	−0.27	**0.045**	0.03	0.888	0.02	0.895	0.02	0.920	−0.03	0.849	0.07	0.722
	M2 + SB + MVPA + CRF	−0.03	0.867	−0.07	0.718	0.25	0.163	−0.02	0.940	−0.03	0.897	0.18	0.420	−0.12	0.590	0.17	0.423
MVPA	M1	−0.30	**0.043**	−0.21	0.178	−0.29	0.061	−0.16	0.379	−0.13	0.497	−0.21	0.200	0.23	0.161	0.01	0.954
	M2							0.00	0.991	0.07	0.657	−0.21	0.229	0.18	0.287	0.07	0.713
	M2 + LPA	−0.21	0.242	−0.10	0.599	−0.07	0.689	0.00	0.994	0.09	0.654	−0.28	0.174	0.20	0.442	0.06	0.792
	M2 + SB	−0.25	0.093	0.03	0.873	0.05	0.776	0.01	0.965	0.11	0.620	−0.12	0.588	0.21	0.334	0.51	**0.023**
	M2 + TPA	−0.08	0.762	0.01	0.980	0.12	0.644	−0.06	0.845	0.14	0.615	−0.21	0.491	0.25	0.217	0.15	0.669
	M2 + CRF	−0.10	0.536	−0.12	0.529	−0.06	0.717	0.09	0.654	0.11	0.549	−0.18	0.362	0.12	0.518	0.16	0.468
	M2 + SB + LPA + CRF	0.07	0.722	0.10	0.660	0.25	0.163	0.10	0.690	0.16	0.534	−0.15	0.550	0.31	0.239	0.54	**0.033**
	M2 + SB + TPA + CRF	0.07	0.761	0.12	0.677	0.30	0.197	0.02	0.943	0.19	0.550	−0.12	0.704	0.26	0.403	0.48	0.122
TPA	M1	−0.32	**0.024**	−0.25	0.097	−0.38	**0.008**	−0.19	0.277	−0.23	0.197	−0.17	0.290	0.17	0.268	−0.05	0.784
	M2							0.03	0.872	0.03	0.863	−0.18	0.329	0.11	0.524	0.03	0.898
	M2 + SB	−0.10	0.586	−0.03	0.888	−0.11	0.545	0.05	0.819	0.04	0.872	−0.06	0.791	0.10	0.660	0.44	0.057
	M2 + MVPA	−0.26	0.295	−0.26	0.342	−0.48	0.061	0.08	0.802	−0.09	0.761	−0.01	0.980	−0.11	0.720	−0.09	0.788
	M2 + CRF	−0.13	0.389	−0.17	0.332	−0.19	0.214	0.11	0.576	0.05	0.775	−0.13	0.609	0.04	0.823	0.09	0.671
	M2 + SB + MVPA + CRF	−0.09	0.700	−0.06	0.821	−0.18	0.436	0.11	0.724	−0.06	0.839	0.06	0.860	−0.12	0.715	0.19	0.534
CRF	M1	−0.42	**0.026**	−0.29	0.118	−0.55	**0.001**	−0.45	**0.028**	−0.40	0.058	−0.18	0.350	0.30	0.113	−0.22	0.296
	M2							−0.21	0.359	−0.05	0.807	−0.20	0.393	0.25	0.265	−0.18	0.492
	M2 + SB	−0.46	**0.005**	−0.12	0.553	−0.37	**0.034**	−0.22	0.357	−0.06	0.791	−0.13	0.575	0.24	0.311	−0.05	0.850
	M2 + LPA	−0.45	**0.010**	−0.21	0.293	−0.43	**0.011**	−0.21	0.362	−0.06	0.798	−0.20	0.399	0.26	0.267	−0.19	0.472
	M2 + MVPA	−0.45	**0.018**	−0.22	0.317	−0.52	**0.009**	−0.26	0.314	−0.12	0.634	−0.10	0.708	0.18	0.470	−0.27	0.355
	M2 + TPA	−0.42	**0.026**	−0.17	0.423	−0.43	**0.026**	−0.26	0.294	−0.08	0.740	−0.13	0.609	0.23	0.355	−0.23	0.431
	M2 + SB + LPA	−0.37	**0.039**	−0.11	0.583	−0.35	**0.045**	−0.22	0.366	−0.06	0.793	−0.14	0.565	0.24	0.315	−0.06	0.808
	M2 + SB + MVPA	−0.42	**0.026**	−0.14	0.505	−0.42	**0.021**	−0.26	0.323	−0.12	0.637	−0.10	0.701	0.18	0.481	−0.29	0.250
	M2 + SB + TPA	−0.38	**0.043**	−0.12	0.570	−0.37	**0.046**	−0.26	0.305	−0.08	0.745	−0.13	0.622	0.23	0.365	−0.21	0.400

Notes: M1 is adjusted for gender, age, smoking, education, severity of psychiatric symptoms, illness duration, and chlorpromazine dose. M2 is adjusted for all covariates in M1 and adjusted for waist circumference (except when CCRS, No. of meeting MetS and Waist were the outcomes). Analyses were conducted with MVPA and TG logarithmically-transformed, and FBG reciprocally-transformed, to obtain a normal distribution.
CCRS: clustered-cardiometabolic risk score; CRF: cardiorespiratory fitness; DBP: diastolic blood pressure; FBG: fasting blood glucose; HDL-C: high-density lipoprotein cholesterol; LPA: light physical activity; M: model; MetS: metabolic syndrome; MVPA: moderate-to-vigorous physical activity; SB: sedentary behaviour; SBP: systolic blood pressure; TG: triglycerides; TPA: total physical activity, Waist: waist circumference.
Boldface indicates statistical significance (p-value < 0.05).
[a] According to the International Diabetes Federation-criteria.

Our results indicated that CRF and SB are both related to waist, independent from each other and from PA, suggesting that CRF and SB are two independent predictors of waist. Consistent findings in patients with psychosis have revealed significant associations between CRF and waist accounting for self-reported PA (Nyboe et al., 2015; Vancampfort et al., 2015a). However, our results were inconsistent with the findings of the only study in patients with psychosis that explored the SB-waist association adjusting for PA (Stubbs et al., 2017). This discrepancy may be because the authors of that study (Stubbs et al., 2017) used accelerometers to obtain an objective indirect estimations of SB and PA through the absence of whole-body movement and the number of steps, respectively, which could introduce bias for both exposures. Considering SB as the absence of whole-body movement is an important conceptual error (Sedentary Behaviour Research, 2012), and the number of steps only provides a value of total ambulatory PA, thereby excluding a range of free-living physical activities aside from walking and or running, such as gardening or washing, which have shown beneficial effects on cardiovascular health (van den Berg et al., 2010). Accordingly, the use of sensor combining physiological measures with movement and position sensing to identify SB and PA may be a more appropriate way to obtain accurate results.

Again, inconsistent with the aforementioned study (Stubbs et al., 2017), our results showed that the relationship between SB and fasting blood glucose remained significant when adjusting for PA. Discrepancies between studies can be explained, in addition to the different instruments of assessment of SB and PA used, because we assessed PA at different intensities and controlled for waist, a predisposing factor for the development of type 2 diabetes mellitus (Freemantle et al., 2008), showing that the SB-fasting blood glucose association did not vary. Additionally, our findings remained significant even when CRF was included with the rest of the confounders, suggesting that SB seems to be an important and independent risk factor for fasting blood glucose in patients with psychosis. However, further research combining SB, PA, and CRF interactions with cardiometabolic outcomes in patients with psychosis is needed before any firm conclusions can be made.

The major strength of the study is the objective measurement of SB and PA using strict inclusion criteria. All patients wore the SenseWear for seven consecutive days with at least 1368 min/day, and the Hawthorne effect (explained in brief in the method section) was minimized. Another strength is the use of the time spent in different intensities of PA which extends the knowledge on the independent association of SB, PA, and CRF with cardiometabolic risk and informs, in greater detail, on intervention strategies for treating metabolic disorders among patients with psychosis focused on the development of a more active lifestyle that enhance/maintain CRF. Finally, the adjustment for covariates that could influence the relationships between SB, PA, and CRF with cardiometabolic risk can also be considered a strength. Multiple linear regression analyses were adjusted for obesity in addition to other covariates such as gender, age, smoking, education, symptom severity, illness duration, and antipsychotic medication, previously controlled in psychiatric patients studies (i.e., Stubbs et al., 2017). This approach was only applied in two (Shuval et al., 2014; van der Velde et al., 2015) of the six studies (Ekblom et al., 2015; Greer et al., 2015; Knaeps et al., 2016a; Knaeps et al., 2016b; Shuval et al., 2014; van der Velde et al., 2015) that evaluated the independent associations of SB, PA, and CRF with cardiometabolic risk.

Some limitations should be noted. The small sample size of outpatients, predominantly men diagnosed with schizophrenia, may limit the generalization to other groups. Future research should use large and homogeneous sample, and compare between different clinical settings, genders, and psychiatric disorders. Another limitation is that the current study was cross-sectional in design. Longitudinal studies are needed to identify any casual relationships. Although the absence of control group can be considered a study limitation, we compared our data against all published studies that have examined the independent associations of SB, PA, and CRF with cardiometabolic risk, each of which is based on observations from hundreds of healthy individuals. Nevertheless, further studies including control group are required to confirm or refute our findings. The SenseWear cannot differentiate body positions, and consequently, standing may be considered as SB. However, it may solve limitations presented by accelerometers and inclinometers through heat production measurements and placement on the upper arm. Additionally, the SenseWear underestimates energy expenditure at higher PA intensities (Drenowatz and Eisenmann, 2011). However, because we used time engaged in moderate-to-vigorous PA, it is unlikely that this affected our results. Moreover, because the objective measurement did not inform about the type of SB and PA, future studies should combine objective with self-report measurements. In patients with severe mental illness, the Sedentary Behaviour and the International Physical Activity questionnaires seem appropriate for quantifying time engaged in different SBs (Bueno-Antequera et al., 2017) and PAs (Faulkner et al., 2006), respectively. The assessment of CRF using an indirect measurement and a submaximal test could be considered as another limitation. However, the test used in this study has been found to be a reliable and valid method in patients with psychosis (Gomes et al., 2016). The CCRS has several advantages for evaluating cardiometabolic risk (Wijndaele et al., 2006), is sample-specific and is based on the assumption that each component is weighted equally in predicting cardiometabolic risk. Finally, dietary information was not considered as a covariate, and the data on symptomatology was self-reported.

In conclusion, low CRF was found to be a predictor of high clustered-cardiometabolic risk independent of multiple confounders, including SB and PA, in patients with psychosis. This study further found associations of SB, PA, and CRF with individual-cardiometabolic risk factors. Therefore, in addition to developing interventions to reduce SB and increase PA, interventions of randomized controlled trials of physical exercise in patients with psychosis are needed to determine whether reduced CRF and increased cardiometabolic risk can be improved.

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Contributors

JB and DM designed the study and wrote the protocol. All authors were responsible for the acquisition of the data. JB and DM performed the statistical analyses and JB wrote the manuscript. All authors provided critical review of the manuscript and approved the final version.

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ESTUDIO 4 [STUDY 4]

Sedentary behaviour patterns in outpatients with severe mental illness: a cross-sectional study using objective and self-reported methods. The PsychiActive project.

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Sedentary behaviour patterns in outpatients with severe mental illness: a cross-sectional study using objective and self-reported methods. The PsychiActive project

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Health Behaviour

ABSTRACT

This study aimed to quantify and compare sedentary behaviour patterns in patients with severe mental illness as stratified by gender, age, body mass index, distress, illness duration and antipsychotic medication using both objective and self-reported methods. Sedentary behaviour patterns were measured in 90 outpatients (mean age ± SD: 41.6 ± 9.2 years, 20% women) with severe mental illness (primarily schizophrenia, n = 63) using the SenseWear Armband and the Sedentary Behaviour Questionnaire. They spent 58% of waking time sedentary, primarily watching television. Differences between methods were not significant for the overall group or for stratified groups. Both methods showed significant correlation for weekday for the overall group. According to the stratified groups, youngers showed a significant correlation for weekday and average day sedentary time, and the high illness duration and low antipsychotic medication groups for weekday. Significant differences in sedentary behaviours between stratified groups were only detected with the SenseWear. Patients with severe mental illness had high levels of sedentary behaviours, with watching television being the most prevalently reported. We found a low validity in the self-reported estimates of sedentary time by this population, being higher on weekdays for the overall group and for the younger, high illness duration and low antipsychotic medication groups.

1. Introduction

Sedentary behaviour is defined as any waking activity characterized by an energy expenditure ≤1.5 metabolic equivalents while in a sitting or reclining posture (Sedentary Behaviour Research, 2012). High levels of sedentary behaviour are associated with an increased risk of morbidity and all-cause mortality independently of a lack of physical activity in the general population (Biswas et al., 2015). A recent meta-analysis found that patients with severe mental illness engaged in significantly more sedentary behaviour than did the general population (Stubbs et al., 2016b). Considering the high levels of cardiometabolic abnormalities (Vancampfort et al., 2016a, 2015) and the negative impacts of sedentary behaviour in patients with severe mental illness such as increased inflammation (Stubbs et al., 2015) and impaired cognition (Stubbs et al., 2016a), reducing excessive sedentary behaviour represents an important strategy for maintaining health in this population.

A key factor for improving our understanding of the impact of sedentary behaviour on the health of patients with severe mental illness and the effectiveness of interventions aimed to reduce sedentary time is to use objective and self-reported methods for accurately quantifying sedentary behaviour patterns. Few studies have objectively measured sedentary in patients with severe mental illness, and all studies used accelerometers (e.g., (Janney et al., 2013; Lindamer et al., 2008; Stubbs et al., 2016a)) except for two small-sample studies (Leutwyler et al., 2014; Vancampfort et al., 2016d) which employed multisensor armbands; however, both studies made an important conceptual mistake in considering sleep as a sedentary behaviour (Sedentary Behaviour Research, 2012). Other studies utilized self-report measures (Schuch et al., 2017; Stubbs et al., 2016b; Vancampfort et al., 2016b), but only two employed domain-specific questionnaires to measure sedentary behaviours (Chapman et al., 2016; Fraser et al., 2016). Self-report measures of specific sedentary behaviours (e.g., watching television) can provide useful information to identify high-risk sedentary behaviours. Nevertheless, there is no domain-specific sedentary behaviour questionnaire that has been validated in patients with severe mental

List of abbreviations: BMI, Body mass index; SBQ, Sedentary Behaviour Questionnaire; SWA, SenseWear Armband

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illness (Soundy et al., 2014). Thus, the validation of domain-specific sedentary behaviour questionnaires in this population is urgently needed.

The identification of high-sedentary behaviour subgroups and the factors that influence the suitability of sedentary behaviour questionnaires are of clinical and public health interest and may inform potential interventions for reducing sedentary time among patients with severe mental illness. The validity of sedentary behaviour questionnaires in these patients stratified by gender, age, body mass index (BMI), level of distress, illness duration and antipsychotic medication use subgroups and the ability of objective and self-reported measurement methods to distinguish between sedentary time levels remain unexplored.

The aim of this study was to quantify and compare the sedentary behaviour patterns in patients with severe mental illness stratified by gender, age, BMI, distress, illness duration and use of antipsychotic medication using both objective and self-reported methods. We also investigated if objective and self-reported methods can identify differences between stratified groups in the amount of time spent in sedentary activities.

2. Methods

2.1. Participants and procedures

This was a cross-sectional study. A convenience sample of patients with severe mental illness was recruited from 13 different outpatient mental healthcare settings in Southern Spain. Patients with a range of ICD-10 diagnosis (see Table 1) established by experienced psychiatrists were included if they aged 18 years or older and were stable on antipsychotic medication during the last month. Patients were excluded if they had clinical instability, co-morbid substance abuse and evidence of uncontrolled cardiovascular, neuromuscular and endocrine disorders. Patients were asked to wear a multisensor armband for 9 consecutive days, starting the same day they received the monitor. At day 9, patients returned the monitor to the researchers and completed a domain-specific sedentary standardized questionnaire. Subsequently, distress level, height and weight were assessed. The study procedure was approved by The Universidad Pablo de Olavide Ethics Committee. All patients gave their informed written consent prior to enrolling in the study and after receiving information about the aims and protocol. There was no compensation for participation in the study.

2.2. Measures

The multisensor SenseWear Pro3 Armband (SWA; BodyMedia Inc., Pittsburgh, PA, USA), was used to objectively assess sedentary behaviour that involves any activity characterized by an energy expenditure ≤1.5 metabolic equivalents during waking hours. Energy expenditure was estimated combining data recorded from multiple sensors (a two-axis accelerometer and sensors measuring heat flux, galvanic skin and near body-temperature) and using specific algorithms developed by the manufacturer (SenseWear Professional software, version 8.1). The SWA has been shown to accurately estimate energy expenditure (Johannsen et al., 2010) and was previously used to measure sedentary behaviour in non-clinical (Barone Gibbs et al., 2016) and clinical populations (Bond et al., 2013). Patients were required to wear the SWA on their left arm triceps muscle, over the whole day (24 h), for 9 consecutive days, except when showering or swimming. The first and last days were excluded from the analysis to minimize Hawthorne effect (Corder et al., 2008). A total of 7 days of recording with a minimum of 1368 min of registration per day (95% of a 24-h period) was necessary to be included in the study analysis.

Self-reported sedentary behaviour was measured using the Spanish version (Munguia-Izquierdo et al., 2013) of Sedentary Behaviour Questionnaire (SBQ) (Rosenberg et al., 2010). The SBQ asks about amount of time spent doing 11 sedentary behaviours (specified in Table 1) of a usual weekday and weekend day. Time in hours of each behaviour were summed separately for weekdays and weekend days, and time for an average day was calculated as (weekday hours $\times 5+$ weekend day hours $\times 2)/7$. Patients with more than 18 h/day reported by the SBQ were excluded as previously done (Van Cauwenberg et al., 2015). The SBQ shown acceptable measurement properties in overweight adults (Rosenberg et al., 2010) and in Spanish patients with fibromyalgia (Munguia-Izquierdo et al., 2013).

Distress in the previous week was assessed using the Spanish version (Andreu et al., 2008) of the Brief Symptoms Inventory-18 (Derogatis, 2001), which has demonstrated satisfactory psychometric properties in outpatients with severe mental illness (Andreu et al., 2008). Scores range from 0 to 72, with higher scores indicating a higher level of distress.

Weight and height (used to derive BMI) were measured following standard procedures with a scale (TANITA BC-420; Tanita, Tokyo, Japan) and a wall-mounted stadiometer, respectively.

Age, diagnoses, illness duration and antipsychotic medication were

Table 1
Patients' characteristics ($n=90$).

Variable	Value
Age (years)	41.6 ± 9.2
BMI (kg/m^2)	30.0 ± 5.8
Distress[a,b]	17.8 ± 13.2
Illness duration (years)[a]	16.2 ± 9.3
Chlorpromazine equivalent dose (mg/day)[a]	620.2 ± 524.3
Total objective sedentary time (hours/day, % of waking time)	8.9 ± 2.4 (58.8)
Total self-reported sedentary time (hours/day)	9.2 ± 3.6
Specific sedentary behaviours (hours/day, % cases)	
Watching television	2.2 ± 1.8 (93.3)
Eating	0.8 ± 0.6 (98.9)
Lying/resting	2.0 ± 1.8 (88.9)
Playing computer/video games	0.4 ± 0.9 (27.8)
Listening to music	1.1 ± 1.5 (68.9)
Talking with others	0.8 ± 1.1 (87.8)
Doing paper/office work	0.4 ± 1.0 (40.0)
Reading	0.5 ± 0.8 (61.1)
Playing a musical instrument	0.1 ± 0.4 (6.7)
Doing arts and crafts	0.5 ± 1.0 (35.6)
Driving/travelling in a motor vehicle	0.8 ± 0.8 (83.3)
Women	18 (20.0)
Diagnoses[a,c]	
Schizophrenia, schizotypal and delusional disorders	63 (71.6)
Mood [affective] disorders	11 (12.5)
Disorders of adult personality and behaviour	8 (9.1)
Neurotic, stress-related and somatoform disorders	3 (3.4)
Mental retardation	2 (2.3)
Mental and behavioural disorders due to psychoactive substance use	1 (1.1)
Marital status	
Married	6 (6.7)
Unmarried	72 (80.0)
Separated/divorced	12 (13.3)
Educational status	
Unfinished studies	18 (20.5)
Primary school	47 (53.4)
Secondary school	13 (14.8)
University degree	10 (11.4)
Occupational status	
Working	6 (6.7)
Unemployed	31 (34.4)
Retired	53 (58.9)

Note. Values are in mean ± SD or n (%). Sedentary data is for an average day.
[a] Missing data: Distress ($n=7$); Illness duration and Chlorpromazine equivalent dose (both $n=10$); Diagnoses ($n=2$).
[b] Distress derived from the Spanish version of the Brief Symptoms Inventory-18; with higher scores indicating a higher level of distress.
[c] Diagnoses consistent with the ICD-10 categories for severe mental illness.

retrieved from patient's medical records. Antipsychotic medication was converted into a daily equivalent dosage of chlorpromazine (Gardner et al., 2010).

2.3. Statistical analysis

The characteristics of patients who completed the SWA, SBQ and both the SWA and SBQ with valid data sets were compared with either a one-way ANOVA with Bonferroni corrections or with chi-squared tests. However, only patients who completed both measures with complete valid data sets were included in final analysis. Patients were classified as either non-obese (BMI < 30) or obese (BMI ≥30), and into groups according to high or low levels of age, distress, illness duration, and chlorpromazine equivalent dose low levels of age, distress, illness duration, and chlorpromazine equivalent dose using a median split procedure. Due to non-normality in data distribution, log-transformed data of sedentary time was used for analyses. Systematic differences between methods were calculated by means of paired *t*-test. Concordance between methods was studied with Concordance correlation coefficient (Lin, 1989). Pearson's correlation coefficient was used as additional information to compare to existing validity studies for sedentary behaviour questionnaires. Agreement between methods was assessed using Bland-Altmant plots (Bland and Altman, 1986) including the 95% levels of agreement. The association between the difference and the magnitude of the measurement was examined by regression analysis. Differences between weekday and weekend sedentary time were estimated with one-way ANOVA repeated measures. Differences between groups in the amount of time spent in sedentary activities were analysed with a one-way ANOVA. Time required to complete the SBQ was recorded and floor and ceiling effect were calculated. Data were analysed using SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp) with statistical significance set at $P < 0.05$.

3. Results

Of the 124 patients who provided written consent, 103 (83%) and 104 (84%) completed the SWA and SBQ with valid datasets, respectively. Reasons for invalid SWA data included refusal to wear the SWA ($n=4$), unregistered data attributed to technical problems ($n=5$) and unmet wear-time criteria ($n=12$). Reasons for invalid SBQ data included refusal to fill out the SBQ ($n=3$), incomplete questionnaire ($n=4$) and more than 18 h/day of sedentary time reported ($n=13$; one of them reported more than 24 h/day). Finally, the characteristics of the 90 patients (73%) who fulfilled both SWA and SBQ requirements are summarized in Table 1. A comparison of patients who completed the SWA, SBQ and both SWA and SBQ with valid datasets showed no significant differences in any variable (data not shown).

Across all days, sitting while eating and watching television were the most frequently reported behaviours. The five most frequently reported behaviours accounted 70% of the total self-reported daily sedentary time. The least frequently reported sedentary behaviour was playing a musical instrument. The behaviour with the highest reported amount of sedentary time was watching television. A total of 27% of patients reported spending more than 3 h per day watching television. The behaviour with the lowest reported amount of sedentary time was playing a musical instrument (Table 1). The mean time required to complete the SBQ was 6.5 (SD = 3.9) minutes per patient (range 1–20 min), and no floor (0%) or ceiling (1%) effects were observed.

The SBQ slightly overestimated the amount of sedentary time (from 5% to 8% for weekdays, weekend days, and an average day) compared to the SWA, but the differences between measures were not significant. The SBQ and SWA data showed a low but significant correlation with one another for weekday sedentary time ($r=0.21$, $P=0.044$), and a borderline significant trend in average day sedentary time ($r=0.20$, $P=0.053$) for the total sample (Table 2). The Bland-Altman plots and the wide limits of agreement between the SBQ and SWA measurements for weekdays (8.37, −6.82), weekend days (9.44, −8.53) and average day sedentary time (8.23, −6.89) are shown in Fig. 1. There was no association between the difference and the magnitude of the SBQ and SWA measurements for weekday, weekend day, and average day sedentary time. According to stratified groups, no significant differences in sedentary time between the measures were found for weekdays, weekend days, and average day. The younger group showed significant correlation coefficients for weekday and average day sedentary time (all $P < 0.05$). High illness duration and low antipsychotic medication groups showed significant correlation coefficients for weekday sedentary time (both $P < 0.05$) (Table 2).

Table 3 summarizes sedentary time data according to the SWA and SBQ by gender, age, BMI, distress, illness duration and antipsychotic medication. No differences between weekday and weekend day total sedentary time were found, except for those with low distress who spent more time on sedentary activities on weekend days ($P=0.034$). Obese and high distress groups showed greater weekday and average day sedentary time than did their respective counterparts (all $P < 0.05$). These significant differences were only encountered using the SWA.

Additional analysis that included only schizophrenia patients showed no significant differences between measures and no significant differences between weekday and weekend day sedentary time according to the SWA and SBQ; however, significant correlations were found among weekday, weekend day, and average day sedentary time (*r* values, 0.31, 0.25 and 0.32, respectively; all $P < 0.05$; data not shown).

4. Discussion

4.1. General findings

This is the first study to quantify and compare sedentary behaviour patterns using the SWA and a standardized domain-specific sedentary behaviour questionnaire among patients with severe mental illness; it is also the first study to evaluate if objective and self-reported methods can identify differences in the amount of time spent in sedentary activities in this population. The findings indicate that the questionnaire presents low validity but acceptable agreement at the group level when compared against sedentary time data from the SWA. This questionnaire may, therefore, be appropriate for identifying high-risk sedentary behaviours and quantifying sedentary behaviour patterns in large-scale studies of patients with severe mental illnesses; additionally, this questionnaire requires little time for completion and does not exhibit floor or ceiling effects (Terwee et al., 2007). However, our results also suggest that the SWA, but not the questionnaire, can identify differences between groups in the amount of time spent in sedentary activities.

In the present study, objective measurement showed that patients spent 58% of their waking time engaged in sedentary behaviours. These findings are similar to those reported by a previous study in outpatients with severe mental illnesses (Chapman et al., 2016; Lindamer et al., 2008). However, another study found that outpatients with schizophrenia spent an average of 81% of their waking time in sedentary activities (Janney et al., 2013). The different diagnoses of patients in these studies may have contributed to these differences in their respective data. The SBQ provides information regarding specific sedentary behaviours of patients with severe mental illnesses. The five most frequently reported behaviours accounted for 70% of the total self-reported daily sedentary time. One of the most prevalent and frequently reported behaviours was watching television. This is an important finding as excessive television viewing is associated with adverse health effects (Biswas et al., 2015). Nearly a quarter of our patients reported spend more than 3 h per day viewing television, a behaviour that was found by a recent meta-analysis (Grontved and Hu, 2011) to increase the relative risk of all-cause mortality. Consequently, watching television may be an important modifiable behaviour for reducing total sedentary time in patients with severe mental illness.

Table 2
Comparison between objective and self-reported methods in outpatients with severe mental illness.

		Weekday				Weekend				Average day			
	n[a]	DM (SD)	CCC	Correlation (*r*)	*p*-value	DM (SD)	CCC	Correlation (*r*)	*p*-value	DM (SD)	CCC	Correlation (*r*)	*p*-value
All	90	0.8 (3.9)	0.20	0.21	0.044	0.5 (4.6)	0.15	0.16	0.132	0.7 (3.9)	0.19	0.20	0.053
Gender													
Men	72	1.2 (3.9)	0.21	0.22	0.058	0.7 (4.6)	0.16	0.17	0.146	1.0 (3.9)	0.21	0.22	0.061
Women	18	−0.9 (3.5)	0.12	0.41	0.088	−0.3 (4.5)	0.10	0.14	0.572	−0.7 (3.6)	0.18	0.31	0.212
Age (years)													
22–41	46	1.1 (3.8)	0.26	0.30	0.040	0.5 (4.4)	0.18	0.20	0.173	0.9 (3.7)	0.25	0.29	0.049
42–69	44	0.5 (4.9)	0.11	0.11	0.473	0.4 (4.8)	0.08	0.08	0.600	0.4 (4.0)	0.10	0.10	0.521
BMI category													
Non-obese (BMI < 30)	49	1.1 (4.1)	0.16	0.17	0.247	0.5 (4.6)	0.16	0.17	0.231	0.9 (4.1)	0.15	0.16	0.258
Obese (BMI ≥30)	41	0.4 (3.6)	0.19	0.23	0.150	0.4 (4.7)	0.09	0.10	0.524	0.4 (3.6)	0.18	0.22	0.172
Distress[b]													
0–15	40	0.7 (4.0)	0.13	0.14	0.373	−0.2 (4.7)	0.14	0.08	0.643	0.4 (4.1)	0.10	0.12	0.464
17–57	43	0.4 (3.8)	0.30	0.23	0.133	0.4 (4.3)	0.14	0.24	0.120	0.3 (3.7)	0.28	0.25	0.105
Illness duration (years)													
1–15	39	0.8 (4.2)	0.15	0.16	0.326	0.4 (4.9)	0.19	0.21	0.204	0.7 (4.2)	0.15	0.17	0.311
16–43	41	0.7 (3.5)	0.29	0.31	0.047	0.4 (4.2)	0.01	0.01	0.973	0.6 (3.4)	0.24	0.26	0.100
Chlorpromazine equivalent dose (mg/day)													
0–570	40	1.2 (3.7)	0.38	0.31	0.049	0.9 (4.8)	0.14	0.12	0.455	1.0 (3.8)	0.32	0.27	0.092
574–2675	40	0.9 (3.8)	0.16	0.22	0.179	0.5 (4.7)	0.14	0.19	0.237	0.7 (3.7)	0.16	0.23	0.154

Note: Analyses were conducted with sedentary time logarithmically transformed to obtain a normal distribution, yet crude values are presented in the table for easier interpretation. Boldface indicates statistical significance ($P < 0.05$).

CCC: concordance correlation coefficient; DM: difference mean; *r*: Pearson's correlation coefficient.

[a] *n* varies due to missing data.

[b] Distress derived from the Spanish version of the Brief Symptoms Inventory-18; with higher scores indicating a higher level of distress.

Our finding that the questionnaire slightly overestimated the amount of time spent in sedentary behaviour compared with that found by the objective measure is consistent with the findings of a recent study (Chapman et al., 2016) but was inconsistent with three meta-analyses among patients with severe mental illness (Schuch et al., 2017; Stubbs et al., 2016b; Vancampfort et al., 2016b). These discrepancies may be because the three meta-analyses included studies that measured sedentary behaviour with either an objective or a self-report measure and thereby compared objective and self-reported sedentary time data from different samples with each other. Therefore, more research that combines both objective and self-reported sedentary behaviour assessment methods in patients with severe mental illness are needed before any firm conclusion can be made.

The present study showed no differences in sedentary behaviour time between measures; however, it did show a low but significant correlation between measures except weekend days, suggesting that the SBQ may be more suitable for weekday use. When analysing only the data gathered from patients with schizophrenia, a significant correlation for weekend days was found, although the correlation coefficient was lower for weekend days than for weekdays. Consistent with a study that used the same measurement tools in other clinical populations (Bond et al., 2013), these findings may be explained by the less structured nature of weekend activities that may make them more difficult to recall than weekday activities. One potential reason for the low relationship between measurement methods might be that patients with severe mental illness have difficulties recalling sedentary time (Chapman et al., 2015; Soundy et al., 2014), partly due to cognitive impairments (Hill et al., 2013), which are even more pronounced in patients who are more sedentary (Stubbs et al., 2016a). In addition, the small mean differences and the wide limits of agreement between the two measurement methods suggests that the SBQ may be most appropriate for quantifying sedentary behaviour patterns in large-scale studies of patients with severe mental illness, rather than for studies requiring accurate estimates at an individual level, concurring with previous studies using the same measurement tools and similar methodologies in other populations (Bond et al., 2013; Munguia-Izquierdo et al., 2013).

In contrast to our results, the aforementioned study (Chapman et al., 2016) found that self-reported sedentary time was significantly higher than objectively measured sedentary time and that the two were not significantly correlated. The conflicting results with this study may be because they employed different self-reported and objective measurement tools of sedentary behaviour. The previous study used a non-standardized domain-specific questionnaire with fewer types of sedentary behaviour than measured by the SBQ that might not have accurately captured data regarding sedentary time. Furthermore, the authors of that study used accelerometers as an objective indirect estimation of sedentary behaviour by measuring periods of reduced movement during waking hours identified from diaries and with accelerometer consecutive zero counts ≥60 min, which could misclassify sedentary time. However, considering sedentary behaviour as the absence of whole-body movement is an error (Sedentary Behaviour Research, 2012) and, therefore, the use of an accelerometer for measuring sedentary behaviour may be questioned. We use the SWA to identify sedentary behaviour according to energy expenditure (≤1.5 metabolic equivalents) during waking hours through multiple sensors.

According to stratified groups, the younger group showed a significantly higher correlation coefficient between self-report and objective measurement methods for weekday and average day sedentary time than did their counterparts in the older age group, demonstrating higher levels of validity between the measurement methods. Consistent with other studies (Ferrari et al., 2007), these results indicate that younger participants have fewer difficulties accurately reporting their sedentary behaviour levels. Low antipsychotic medication and high illness duration groups showed significant and higher correlation coefficients for weekdays than did their counterparts. The finding that lower doses of antipsychotic medication correlated with more accurate recall of sedentary behaviour could be expected because low doses are associated with high cognitive functioning (Elie et al., 2010) that can facilitate recall; the result of high illness duration correlated with more accurate recall may be explained by a higher awareness of sedentary behaviour patterns over the course of their

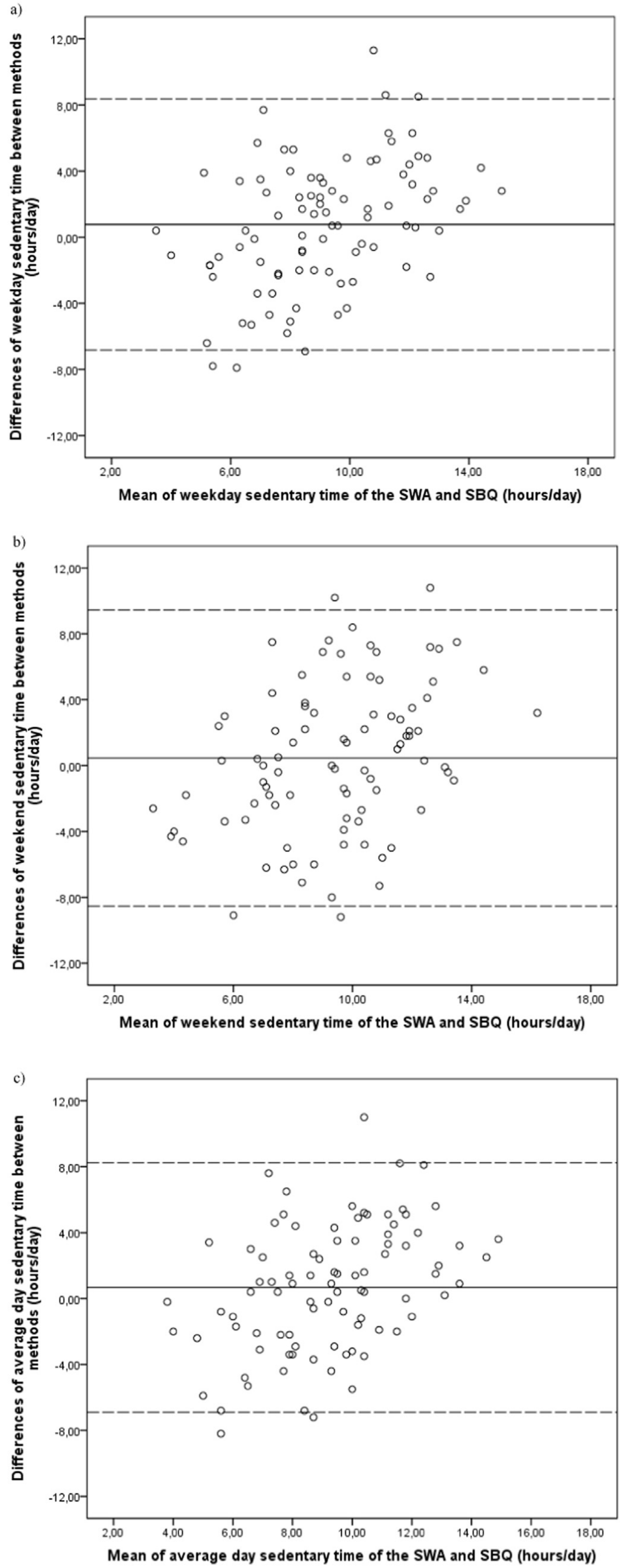

Fig. 1. Bland-Altman plots for the sedentary time for the SenseWear Armband (SWA) and the Sedentary Behaviour Questionnaire (SBQ), separately for (a) weekday, (b) weekend, and (c) average day. The means of the differences (solid lines) and limits of agreement (dashed lines) within ± 1.96 standard deviations are shown.

Table 3
Objective and self-reported sedentary behaviour in outpatients with severe mental illness by stratified groups.

		Weekday sedentary time (hours/day) DM (SD)		Weekend sedentary time (hours/day) DM (SD)		Average day sedentary time (hours/day) DM (SD)	
	n[a]	SWA	SBQ	SWA	SBQ	SWA	SBQ
Gender							
Men	72	8.6 (2.5)	9.8 (3.6)	9.0 (2.8)	9.7 (4.0)	8.7 (2.5)	9.7 (3.6)
Women	18	9.5 (1.9)	8.7 (4.2)	9.9 (2.5)	9.6 (4.1)	9.6 (1.9)	8.9 (4.0)
p-value		0.106	0.156	0.206	0.789	0.115	0.284
Age (years)							
22–41	46	8.6 (2.4)	9.7 (4.1)	8.9 (2.8)	9.4 (4.1)	8.7 (2.4)	9.6 (3.9)
42–69	44	9.0 (2.5)	9.4 (3.4)	9.5 (2.7)	9.9 (3.9)	9.1 (2.4)	9.5 (3.4)
p-value		0.547	0.942	0.327	0.457	0.457	0.797
BMI category							
Non-obese (BMI < 30)	49	8.1 (2.5)	9.2 (3.9)	8.8 (3.0)	9.4 (4.2)	8.3 (2.6)	9.2 (3.8)
Obese (BMI ≥ 30)	41	9.5 (2.1)	10.0 (3.5)	9.6 (2.5)	10.0 (3.8)	9.6 (2.0)	10.0 (3.4)
p-value		0.003	0.258	0.134	0.381	0.005	0.258
Distress[b]							
0–15	40	8.1 (2.4)	8.7 (3.6)	8.8 (3.0)	8.6 (3.7)	8.3 (2.5)	8.7 (3.5)
17–57	43	9.5 (2.4)	9.8 (3.9)	9.7 (2.6)	10.1 (4.0)	9.6 (2.3)	9.9 (3.7)
p-value		0.010	0.239	0.107	0.115	0.013	0.171
Illness duration (years)							
1–15	39	8.6 (2.7)	9.4 (4.0)	9.2 (3.1)	9.7 (4.3)	8.8 (2.7)	9.5 (4.0)
16–43	41	8.9 (2.2)	9.6 (3.4)	9.0 (2.5)	9.4 (3.4)	9.0 (2.1)	9.5 (3.3)
p-value		0.441	0.615	0.959	0.812	0.565	0.669
Chlorpromazine equivalent dose (mg/day)							
0–570	40	8.5 (2.5)	9.7 (4.1)	9.0 (2.8)	9.9 (4.3)	8.7 (2.4)	9.7 (4.0)
574–2675	40	8.7 (2.4)	9.6 (3.4)	9.1 (2.6)	9.5 (3.7)	8.8 (2.3)	9.6 (3.3)
p-value		0.676	0.776	0.924	0.942	0.721	0.825

Note: Analyses were conducted with sedentary time logarithmically transformed to obtain a normal distribution, yet crude values are presented in the table for easier interpretation. Boldface indicates statistical significance ($P < 0.05$).
SBQ: Sedentary Behaviour Questionnaire; SWA: SenseWear Armband.
[a] n varies due to missing data.
[b] Distress derived from the Spanish version of the Brief Symptoms Inventory-18; with higher scores indicating a higher level of distress.

illness due to more structured daily activities that are easier to report. Further studies should confirm whether illness duration influences the validity of sedentary behaviour questionnaires across patients with severe mental illness.

Although significant differences in sedentary behaviour were only found in those with lower levels of distress, time spent in sedentary behaviour tended to be higher on weekend days than on weekdays, consistent with previous studies in patients with severe mental illness (Yanos and Robilotta, 2011) and in the general population (Burton et al., 2012). The present study also found significant differences in sedentary behaviour between groups stratified by BMI and levels of distress, agreeing with other studies in patients with severe mental illness (Vancampfort et al., 2012, 2016c) and in the general population (Kikuchi et al., 2014). This finding highlights that these groups may have an increased risk for engaging in high levels of sedentary behaviours. Significant differences were only encountered using the SWA, indicating that the SBQ failed to identify differences in the amount of time spent in sedentary activities by patients with severe mental illness. However, our study suggests that the use of both tools may be appropriate to obtain assessments of total sedentary time, as well as time spent in specific behaviours such as sitting and lying.

4.2. Study limitations and strengths

A limitation of the present study is that it included a convenience sample of diagnostically heterogeneous patients with severe mental illnesses that were predominantly men. This limitation may affect the ability of these findings to be generalized to other groups. Future research should use samples of patients who are diagnostically homogeneous and determine whether results are also applicable to women. Another limitation is that the current study was cross-sectional in design. Longitudinal studies are needed to identify any casual relationships and to examine the responsiveness to change of objective and self-reported measures of sedentary behaviour patterns. The absence of a control group without severe mental illness in our study is an additional limitation. The objective sedentary measurement utilized in this study also has its limitations. The SWA is unable to differentiate body position (i.e., sitting, lying, and standing). However, it may solve the main limitations of accelerometers and inclinometers through heat production measurements, differentiating between sleep and waking time, and placement on the upper arm. Future studies using the SWA and inclinometers simultaneously would be an interesting method to objectively measure sedentary behaviour.

Despite these limitations, the present study has several strengths. The main strength of our study is the strict criteria used in measuring sedentary time. All patients wore the SWA during 7 consecutive days with at least 1368 min/day of registered time, and the Hawthorne effect was minimized. Although the minimum wear-time was the most exigent of the criteria applied in this population, few patients were excluded by invalid or incomplete SWA data (17% of sample recruited). Taking into account that the SBQ showed a similar amount of invalid or incomplete data, its quick administration and lack of floor and ceiling effects, our study demonstrates the feasibility of using both objective and self-report methods for measuring sedentary behaviour patterns in patients with severe mental illness. The examination of a sedentary behaviour questionnaire that included an extensive list of specific sedentary behaviours, is another strength. However, to minimize the patient burden and shorten the completion time, we do suggest refining the SBQ further to remove or combine certain questions that had very few responses (e.g., playing a musical instrument).

4.3. Clinical implications

The present study could help to increase health professionals' knowledge of the impact of sedentary behaviour on the health of patients with severe mental illness. It provides a valid, inexpensive, quick and easy to administer tool to assess sedentary behaviour patterns in large-scale studies of this population, primarily in patients with schizophrenia. However, the current findings suggest that the SBQ should be used with caution, particularly when the aim is to calculate an accurate and global measure of sedentary behaviour in patients with severe mental illnesses.

5. Conclusions

Patients with severe mental illness spent more than a half of their waking hours engaged in sedentary behaviours, with watching television being the most reported sedentary activity. We found a low validity of self-reported estimates sedentary time in patients with severe mental illness, although the validity of self-reported estimates was higher on weekdays than on weekend days. According to the stratified groups, we found higher validity among younger patients, those with higher illness duration and those with low antipsychotic medication use than their respective counterparts. The questionnaire utilized can be appropriate for identifying high-risk sedentary behaviours and for quantifying sedentary behaviour patterns in large-scale studies of patients with severe mental illness; additionally, it required little time for completion and did not exhibit floor or ceiling effects. However, the objective measurement method, but not the questionnaire, can identify differences in the amount of time spent in sedentary activities between groups. Therefore, objective and self-reported sedentary measurements are complementary tools to assess sedentary behaviour in patients with severe mental illness.

Conflict of interest

None.

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2. Promoción de la salud a través de estilos de vida activos en personas con trastorno mental grave. (Estudios 5, 6, 7 y 8).

ESTUDIO 5 [STUDY 5]

Recomendaciones para la promoción de la salud a través de estilos de vida activos en personas con trastorno mental grave.

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In press

Recomendaciones para la promoción de la salud a través de estilos de vida activos en personas con trastorno mental grave.

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Introducción

Las personas con trastorno mental grave (TMG) tienen una esperanza de vida 15-30 años inferior a la población general (Walker, McGee, y Druss, 2015) debido al deteriorado estado de salud (De Hert et al., 2011). Es bien sabido que la personas con TMG presentan mayores niveles de obesidad y otros factores de riesgo cardiometabólico (diabetes, hipertensión, hipercolesterolemia, etc.), problemas respiratorios y de movilidad respecto a la población general (De Hert et al., 2011). Estos aspectos favorecen la aparición de enfermedades y por ende perjudican la calidad de vida de vida relacionada con la salud de esta población (Foldemo et al., 2014).

La inactividad física es considerada uno de los principales factores que explican los alarmantes problemas de salud en personas con TMG. Las personas con TMG incumplen habitualmente las recomendaciones mínimas de actividad física para la salud y realizan menos actividad física que la población general (Schuch et al., 2017; Stubbs, Firth, et al., 2016; Vancampfort et al., 2016). Por tanto, aumentar los niveles de actividad física es una estrategia a considerar en la prevención y recuperación de enfermedades de personas con TMG. Por otro lado, el sedentarismo, entendido como la realización de actividades en estado de vigilia de bajo gasto energético mientras se está sentado o tumbado, también supone un gran problema de salud pública independientemente del nivel de actividad física (Biswas et al., 2015). Recientes meta-análisis han comprobado que las personas con TMG son mucho más sedentarias que la población general (Schuch et al., 2017; Stubbs, Williams, Gaughran, y Craig, 2016;

Vancampfort et al., 2016). Un reciente estudio desarrollado en Andalucía (Bueno-Antequera, Oviedo-Caro, y Munguia-Izquierdo, 2017a) mostró que las personas con TMG más sedentarias presentaban mayor índice de masa corporal, mayor severidad de la sintomatología psiquiátrica, menor función cardiorrespiratoria y peor calidad de vida relacionada con la salud respecto a las menos sedentarias. Por tanto, reducir el tiempo en actividades sedentarias podría mejorar el estado de salud de personas con TMG.

El estilo de vida predominantemente sedentario podría explicar los deficitarios niveles de condición física observados en personas con TMG (Strassnig, Brar, y Ganguli, 2011). Este aspecto resulta de interés clínico, ya que la condición física es un potente marcador de morbilidad y mortalidad (Ross et al., 2016), siendo mejor que otros indicadores tradicionales considerados como el índice de masa corporal (Barry et al., 2014). Las circunstancias comentadas ponen de manifiesto que la promoción estilos de vida más activos y mejora de la condición física resultan esenciales en la recuperación de personas con TMG.

A continuación se describen recomendaciones para promover estilos de vida más activos y evaluar los niveles de actividad física, sedentarismo y condición física en personas con TMG. Por último se describe brevemente el proyecto PsychiActive del grupo de Investigación CTS 948 “Actividad física, salud y deporte” de la Universidad Pablo de Olavide, centrado en la promoción de estilos de vida más activos en pacientes con TMG de Andalucía.

Recomendaciones para promover estilos de vida más activos en personas con TMG

<u>Actividad física</u> (basado en U.S. Department of Health and Human Services (2008))

Alguna actividad física es mejor que ninguna.

Para obtener beneficios para la salud adicionales, las personas con TMG deben acumular al menos 150 minutos por semana de intensidad moderada, o 75 minutos de actividad aeróbica de intensidad moderada a vigorosa realizada en periodos de, al menos, 10 minutos consecutivos. Realizar actividad física durante al menos 3 días a la semana ayuda a reducir el riesgo de diversas enfermedades y evita la fatiga excesiva.

Para obtener mayores beneficios para la salud, las personas con TMG deben aumentar su actividad física aeróbica más allá de 300 minutos a la semana de intensidad moderada o 150 minutos a la semana de intensa actividad física aeróbica o una combinación equivalente de actividad de intensidad moderada y vigorosa.

Las personas con TMG también deben realizar 2 o más días a la semana actividades de fortalecimiento muscular de intensidad, al menos, moderada e involucren a todos los grupos musculares principales (piernas, brazos y tronco), ya que estas actividades proporcionan beneficios de salud cardiometabólica adicionales.

Sedentarismo

Para obtener beneficios para la salud, las personas con TMG deben minimizar el tiempo sedentario diario. Esto puede conseguirse limitando el tiempo invertido en ciertas actividades sedentarias, por ejemplo ver televisión a 3 horas al día como máximo. Para una mayor concreción, un reciente estudio desarrollado en Andalucía (Bueno-Antequera, Oviedo-Caro, y Munguia-Izquierdo, 2017b) mostró el tiempo que las personas con TMG dedican a actividades sedentarias (Tabla 1) valorado a través de la versión española (Munguia-Izquierdo et al., 2013) del cuestionario Sedentary Behavior Questionnaire (Rosenberg et al., 2010).

[INSERTAR TABLA 1]

Comer sentado y ver la televisión fueron las conductas sedentarias más frecuentes. Los cinco comportamientos más frecuentemente reportados (ver la televisón, comer, descansar, hablar con otras personas y viajas) representaron el 70% del total de tiempo sedentario diario. El comportamiento sedentario menos frecuente fue tocar un instrumento musical. El comportamiento sedentario con mayor duración fue ver la televisión. Un total de 27% de las personas reportó ver la televisión más de 3 horas al día. El comportamiento con la menor cantidad reportada de tiempo sedentario fue tocar un instrumento musical.

Estos resultados sugieren que ver la televisión podría ser un importante comportamiento modificable para reducir el tiempo sedentario total en pacientes con TMG.

Evaluación de los niveles de actividad física, sedentarismo y condición física en personas con TMG

Para evaluar el nivel de actividad física en personas con TMG se pueden utilizar cuestionarios autoreportados como la versión corta del International Physical Activity Questionaire (IPAQ-SF) (Craig et al., 2003). El IPAQ-SF incluye 9 ítems que permite identificar la frecuencia (días a la semana) y duración (minutos u horas al día) de actividad física realizada en la última semana. El IPAQ-SF proporciona información sobre el tiempo empleado al caminar, en actividades de intensidad moderada y vigorosa y en actividades sedentarias. Esta herramienta permite calcular los minutos semanales de actividad física vigorosa, moderada y caminar, así como el sumatorio de minutos de actividad física de moderada a vigorosa, y de actividad física total. A demás permite clasificar a los sujetos en inactivos, activos o muy activos. Trabajos anteriores indican que el IPAQ-SF es considerada una herramienta útil para valorar el nivel de actividad física en personas con TMG (Faulkner, Cohn, y Remington, 2006). La versión en castellano del IPAQ-SF está disponible gratuitamente en la página web www.ipaq.ki.se.

Para evaluar el nivel de sedentarismo en personas con TMG se pueden utilizar cuestionarios autoreportados como el Sedentary Behavior Questionnaire (SBQ) (Rosenberg et al., 2010). El SBQ pregunta sobre la cantidad de tiempo invertido en 11 actividades sedentarias anteriormente indicadas (Tabla 1) en un día habitual entre semana y en fin de semana. El tiempo en horas de cada comportamiento se suma por separado para días entre semana y días en fin de semana, y el tiempo promedio diario se calcula con la siguiente fórmula (horas entre semana × 5 + horas en fin de semana × 2)/7. En personas con TMG de Andalucía, el SBQ ha mostrado aceptables propiedades psicométricas, sin presentar efecto suelo (0%) ni techo (1%) y siendo 6.5 (SD = 3.9) minutos el tiempo requerido por persona para ser completado (Bueno-Antequera et al., 2017b). La versión adaptada transculturalmente al castellano del SBQ por Munguia-Izquierdo et al. (2013) está disponible gratuitamente en la página web del estudio al-Andalus (http://www.alandalusfibromialgia.com).

Para evaluar el nivel de condición física en personas con TMG se pueden utilizar pruebas de campo como el Test de los 6 minutos caminando. De acuerdo con Rikli & Jones (Rikliy Jones, 1999) se debe realizar en una pista sobre una superficie plana, firme y con mínimos estímulos externos. Los participantes deben caminar lo máximo posible durante un período de 6 minutos alrededor de un recorrido rectangular de 45,7 metros delimitado por conos, sin correr o trotar. Se permite descansar si es necesario, pero la marcha debe reanudarse lo antes posible. Se deben utilizar estímulos estandarizados a intervalos recomendados (Rikliy Jones, 1999). La puntuación de la prueba es la distancia total recorrida en metros. El Test de los 6 minutos caminando ha demostrado ser un método factible, fiable, válido y rentable para evaluar la condición física en personas con TMG (Gomes et al., 2016). Una minuciosa explicación en español del protocolo y recorrido está disponible gratuitamente en la página web de la Red de Investigación en Ejercicio Físico y Salud para Poblaciones Especiales (www.spanishexernet.com).

The PsychiActive project: promoción de estilos de vida activos en personas con TMG en Andalucía

El proyecto PsychiActive liderado por Javier Bueno Antequera y dirigido por Diego Munguía Izquierdo, ambos del grupo de Investigación CTS-948 “Actividad física, salud y deporte” y profesores de la Facultad de Ciencias del Deporte de la Universidad Pablo de Olavide, se inició en el año 2014 con el fin de estudiar la utilidad de la actividad física, comportamiento sedentario y condición física para evaluar el estado de salud, así como el efecto ejercicio físico sobre el estado de salud de personas con TMG. Tras revisar la literatura científica se comprobó que no existen trabajos previos centrados en estudiar el rol del estilo de vida y ejercicio físico en esta población en España. Por estos motivos y considerando, la gran potencialidad y necesidad de este colectivo para beneficiarse de los efectos del ejercicio físico y de estilos de vida activos, los investigadores anteriormente citados afrontaron este reto científico.

El proyecto consta de dos fases.

1. Valoración de personas con TMG, analizando el gasto energético, condición física, calidad de vida y otras variables relacionadas con la salud. Todos los test y herramientas de evaluación que se emplean en esta fase han sido validados científicamente y ampliamente utilizadas en estudios anteriores, resultando adecuadas en esta población.
2. Intervenciones mediante ejercicio físico en personas con TMG.

La participación es totalmente gratuita, siendo condición *sine qua non* recibir primero la valoración inicial para poder participar posteriormente en programas de ejercicio físico supervisado. Para la valoración inicial, tan sólo son necesarias 2 sesiones de evaluación de aproximadamente 60 minutos/sesión que se desarrollan habitualmente en las instalaciones deportivas de la Universidad Pablo de Olavide bajo la supervisión de personal con amplia experiencia en realizar este tipo de valoraciones en personas con TMG. Al finalizar la evaluación, los participantes reciben un informe individualizado con los resultados de las pruebas y valores de referencia que permiten conocer el estado de salud actual. El material utilizado en su mayoría es portátil, por lo que las evaluaciones pueden desarrollarse fuera de la Universidad Pablo de Olavide excepcionalmente.

Hasta la fecha (Marzo 2017) más de 250 personas con TMG han participado en el proyecto, habiéndose realizado varios programas de ejercicio físico controlado y supervisado mostrando importantes mejoras en el estado de salud de estas personas. Con el objetivo de que el mayor número de personas con TMG puedan beneficiarse de la participación el proyecto permanece activo, por lo se anima a las unidades de salud mental y tejido asociativo de personas con TMG a participar en él.

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Tabla 1. Actividades sedentarias en personas con TMG de Andalucía según Bueno-Antequera et al. (2017b).

Actividades	horas/día, % casos
Ver la televisión sentado	2.2 ± 1.8 (93.3)
Comer sentado	0.8 ± 0.6 (98.9)
Descansar sentado-tumbado	2.0 ± 1.8 (88.9)
Jugar ordenador/video-juego sentado	0.4 ± 0.9 (27.8)
Escuchar música sentado	1.1 ± 1.5 (68.9)
Hablar con otras personas sentado	0.8 ± 1.1 (87.8)
Papeleo/trabajo oficina sentado	0.4 ± 1.0 (40.0)
Leer sentado	0.5 ± 0.8 (61.1)
Tocar un instrumento musical sentado	0.1 ± 0.4 (6.7)
Hacer manualidades sentado	0.5 ± 1.0 (35.6)
Viajar en transporte motorizado	0.8 ± 0.8 (83.3)

ESTUDIO 6 [STUDY 6]

Lifestyle changes and cardiovascular health in a woman with bipolar disorder: a case study of the PsychiActive project.

Bueno-Antequera J, Munguía-Izquierdo D.

en Stubbs B, Rosenbaum S (coord.). Exercise-Based Interventions for Mental Illness (1st Edition): Physical Activity as Part of Clinical Treatment. Amsterdam, Netherlands: Academic Press (Elsevier). Paperback ISBN: 9780128126059.

In press

Lifestyle changes and cardiovascular health in a woman with bipolar disorder: a case study of the PsychiActive project.

Javier Bueno-Antequera and Prof Diego Munguía-Izquierdo

Universidad Pablo de Olavide, Seville, Spain

Country	Spain
Professional background / discipline	Exercise Science
Qualification / experience	MS Exercise Science
Occupation	PhD Exercise Science, supported by the Spanish Ministry of Education (grant number FPU13/05130)
1. CLIENT / PATIENT DEMOGRAPHICS	
Occupation	Unfit to work
Sex	Female
Age	39
Diagnosis	Bipolar disorder
Medical history	Length of illness 5 years
Current medication	Combination of first and second generation antipsychotics, Antidepressant, Benzodiazepine, Anticholinergic, Mood stabilizer, Antihypertensive, and Lipid-lowering medication.
Setting	Outpatient
Social context	No currently working, living with her family and two sons
2. ASSESSMENT(S)	
Objective	Physical activity, sedentary behaviour, body mass index, total cholesterol, fasting glucose, blood pressure, fitness.
Self-report	Smoking status, diet, symptom severity.

Silvia is a 39 year old woman with a medical history of bipolar disorder for 5 years, fibromyalgia, osteoporosis, early menopause, hypothyroidism, thalassemia minor, who smokes approximately 40 cigarettes per day with comorbid obesity and persistent back pain, medically unfit to work and who lives independently with her family.

She had agreed to participate voluntarily and without economic compensation in the PsychiActive project that includes cross-sectional and intervention multi-centre studies as an integrated approach to positive health behaviour and healthy lifestyle from people with severe mental illness from Spain.

After received an evaluation of diverse health outcomes, Silvia decided to change her lifestyle on her own, primarily increasing time engaged in physical activity (walking) and eating healthier (replacing fat intake with fruits and vegetables, and habitual breakfast and dinner by nutritional beverages).

The assessment included, among other measures, the 7 ideal components of cardiovascular health defined by the American Heart Association (1), objective sedentary behaviour, fitness and severity of psychiatric symptoms. Identical follow-up measurements were conducted 18 months after. In both times, Silvia was clinically stable, and antipsychotic medication was a combination of first and second generation antipsychotics.

Results

Table 1 summarizes Silvia's characteristics in both situations. 18 months after taking the decision to change her lifestyle habits, Silvia engaged in more active and less sedentary activities, and increased the adherence to Mediterranean diet, achieving 5 of the 7 ideal CVH metrics, which is clinically relevant because this is associated with a lower risk of all-cause and cardiovascular mortality (2). Improvements in anthropometric data (e.g., reduced body mass from 108 to 79 kg), fitness and reductions in severity of psychiatric symptoms and medication use were also found.

Discussion

Our single-study case demonstrated substantial improvements after follow a healthier lifestyle in cardiovascular health, anthropometric data, fitness, which were accompanied by reductions in severity of psychiatric symptoms and medication use.

The higher number of ideal cardiovascular health met at the second visit can be explained because Silvia was engaged in more active and in less sedentary activities, and increased the adherence to Mediterranean diet over the study period. These healthy lifestyle choices were widely related to cardiovascular health improvements (3-5). The notable weight-loss (29 kg) could also explain changes in cardiovascular health concurring with a great amount of scientific studies (6). However, the fitness improvements should be also considered because high levels of physical fitness are more protective of cardiovascular disease morbidity and mortality than low bodyweight/body mass index (7). The reduction in upper-limb strength may be due because the physical activity method selected by Silvia was walking which mainly implies the use of lower-limb muscles. The reductions in severity of psychiatric symptoms and medication use are also of clinical and public health interest suggesting that lifestyle change interventions may also reduce the high cost of medical care for people with bipolar disorder.

In summary, the present single-case study highlights that lifestyle change interventions are feasible, effective and acceptable adjunct to usual care and may protect cardiovascular health of people with bipolar disorder.

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Table 1. Silvia's characteristics

Variable	Baseline	Follow-up
Cardiovascular health		
Smoking	current	current
Body mass index (kg/m^2)	38.7	28.0
Physical activity (min/week)	375	533
Healthy diet pattern (MEDA score)	6	10
Total cholesterol (mg/dL)	183	190
Systolic/Diastolic blood pressure (mm Hg)	128/83	102/71
Fasting plasma glucose (mg/dL)	100	78
Number of ideal criteria fulfilled[a] (n)	2	5
Sedentary time (h/day, % of waking time)	12.0 (82)	7.4 (47)
Fitness		
30-second arm curl (repetitions)	27	23
30-second chair timed-stand (repetitions)	16	20
Six-minute walking (m)	487	573
Severity of psychiatric symptoms[b] (0-72)	40	24
Chlorpromazine equivalent dose (mg/day)	630	150
No antipsychotic medication (-/use)		
Antidepressant	use	-
Benzodiazepine	use	use
Anticholinergic	use	-
Mood stabilizer	use	-
Antidiabetic	-	-
Antihypertensive	use	-
Lipid-lowering medication	use	-

[a]Following the American Heart Association ideal cardiovascular health definition, ideal criteria were: Smoking: never or quit >12 month ago; Body mass index: <25 kg/m^2; Physical activity: ≥ 150 min/week moderate-vigorous physical activity accumulated in bouts of ≥ 10 min (SenseWear Pro3 Armband); Healthy diet pattern (adherence to the Mediterranean diet with scores ≥ 10 in the 14-Item Mediterranean Diet Tool (8); Total cholesterol: <200 mg/dL; Blood pressure: <120/<80 mm Hg; Fasting plasma glucose: <100 mg/dL.

[b]Severity of psychiatric symptoms was assessed using the Spanish version of the Brief Symptoms Inventory-18; with a higher score indicating high severity.

ESTUDIO 7 [STUDY 7]

Exercise improves fitness and anthropometrics measures in psychiatric men inmates: the PsychiActive project randomized controlled trial.

Bueno-Antequera J, Oviedo-Caro MÁ, Munguía-Izquierdo D.

Submitted

Title:

Exercise improves fitness and anthropometrics measures in psychiatric men inmates: the PsychiActive project randomized controlled trial.

Authors:

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Abstract

Objective: The aim was to evaluate the feasibility and effects of an exercise-based intervention on fitness and anthropometric measures in psychiatric inmates. **Method**: Forty-one men inmates (mean age ± SD: 38.2 ± 9.2 years, mean prison duration ± SD: 2.6 ± 2.5 years) with severe mental illness (primarily personality disorder, n = 27) were randomly assigned to usual care (n = 20) or to exercise + usual care (n = 21) during 12 weeks. The intervention consisted of 3 weekly sessions of group-based aerobic and strength exercise supervised by exercise physiologists. Cardiorespiratory fitness, muscular strength, weight, and anthropometric indices were assessed before and after the study period using field-based tests (6-Minute Walk, Incremental Shuttle Walk, Arm-Curl, Chair-Stand), handgrip dynamometry, bioelectrical impedance analysis, and waist and hip circumferences. **Results**: No adverse events and 10 dropouts were reported (24.4%), all in the exercise group. The remaining participants from the exercise group had an attendance rate of 77%, with the majority (9 of 11) attending at least 70% and meeting compliance demands. Between-group change differences substantially favoured the compliance intervention group on 6-Minute Walk Test (+21.2%), Incremental Shuttle Walk Test (+33.9%), Arm-Curl Test (+13.8%), weight (-6.9%), waist (-3.5%), waist-height$^{0.5}$ (-1.7%), waist-hip (-3.4%), and ABSI (-3.3%). Additional analysis suggested beneficial effects of exercise in the handgrip and Chair-stand tests. **Conclusion**: A 12-week group-based intervention of supervised aerobic and strength exercise training was safe, feasible, and effective for improving cardiorespiratory fitness, muscular strength, and anthropometric parameters in psychiatric men inmates.

Key words: Mental disorders, Exercise, Physical fitness, Anthropometry, Prisons.

Introduction

Severe mental illness (SMI) such as schizophrenia, depression, anxiety, and bipolar disorder are the leading cause of cardiovascular disease [1], and premature all-cause death [2] worldwide. In 2010, the global economic burden of SMI was comparable to that of cardiovascular diseases and higher than that of cancer, chronic respiratory diseases, and diabetes, and is expected to double by 2030 [3]. Therefore, it is not surprising that improving the treatment of SMI is a global health priority.

A key factor for improving the treatment and reducing the burden of SMI is exercise-based interventions. A plethora of evidence [4, 5] have consistently demonstrated that exercise-based interventions are a feasible, effective, and acceptable adjunct to usual care for a variety of SMI and provide benefits to both mental and physical health outcomes. However, despite the overwhelming burden of SMI in prison environments [6], which is associated with an increased risk of suicide, self-harm, violence, victimisation, somatic disorders, health care expenditures, and premature mortality on release from prison [6, 7], very few exercise-based intervention studies have been done in this context, and none exclusively in psychiatric inmates. Therefore, understanding the feasibility and effects of exercise-based interventions on the health of psychiatric inmates represents both a challenge and an opportunity for public health and the scientific community.

An essential aspect for understanding the effects of interventions on health is to use adequate measures. A firmly established-base recognized that low levels of cardiorespiratory fitness (CRF) [8] and of muscular strength (MS) [9] are stronger predictors of all-cause and specific-cause morbidity and mortality than traditional cardiovascular risk factors such as age, smoking, or hypertension. Additionally, anthropometric measures are simple, inexpensive, non-invasive tools to assess all-cause and specific-cause morbidity and mortality [10]. For these reasons, fitness and anthropometric measures should be considered for the evaluation and promotion of health. The aim of the current study was to evaluate the feasibility and effects of an exercise-based intervention on fitness and anthropometric measures in psychiatric inmates.

Methods

Men inmates from a penitentiary center (Hospital Psiquiátrico Penitenciario de Sevilla, Spain), with ICD-10 SMI (see Table 1) diagnosed by experienced psychiatrists, aged from 18 to 65 years, and stabilized on antipsychotic medication during the last month, were included. Subjects with clinical instability, substance abuse, or comorbidities contraindicating participation were excluded. After baseline assessment, participants were randomized (ratio 1:1) to control (usual care) or intervention (exercise + usual care) according to a computer-generated randomization list conducted by a researcher (DMI) not involved in assessment. Baseline (before the intervention) and follow-up (after 12 weeks of intervention) assessments, as well as design, implementation, and supervision (face-to-face) of intervention throughout the entire study period were conducted by two exercise physiologists (JBA and MAOV), with more than 5 years of exercise experience and 3 years working as researchers in exercise and SMI prior to this role. This parallel randomized controlled trial followed the CONSORT NPT [11] and CERT [12] guidelines, was approved by the Hospitales Universitarios Vírgen Macarena and Virgen del Rocío Ethics Committee (1674-N-17) and the Ministry of Interior of Spain, and registered in www.clinicaltrials.gov (Identifier: NCT03352544). All participants gave their informed written consent prior to enrolling in the study and after receiving information about the aims and protocol. There was no compensation for participation.

Measures

Feasibility

Feasibility measures were recruitment, attendance, persistence, and dropout. Recruitment rate was defined as number of randomized participants divided by number enrolled by the medical staff. Persistence was defined as number of weeks the participant attended at least one exercise session. Dropout was defined as number of randomized participants who did not complete their treatment. Reasons for non-attendance and dropout were also recorded.

Fitness

CRF was assessed with the distance walked in the 6-Minute Walk Test (6MWT) (to the nearest 0.1 m) and in the Incremental Shuttle Walk Test (ISWT) (to the nearest 10 m) without running or jogging on an indoor course with a flat and firm surface according to Rikli and Jones [13] and Singh [14]. The 6MWT consisted on walking as far as possible during a 6- minute period around a 45.7-meter rectangular course delimited by cones. Resting was allowed if necessary, but walking was to be resumed as soon as possible. The ISWT consisted on walking up and down a 10-meter course (a shuttle) marked by cones. The test was externally paced by audio signals to indicate when the participant should be turning around the cones to commence the next shuttle (single beep) and increments in walking speed (triple beep). To ensure maximal effort and avoid ceiling effect, the modified version without limiting by levels of velocities was used. Initial speed was 0.5 m/s and increased 0.17 m/s each minute until the participant failed to complete two consecutive shuttles in the time allowed. The distance recorded represents completed shuttles only.

MS was assessed with several tests. Handgrip MS was assessed to the nearest 0.1 kg with a hand dynamometer (TKK 5401 Grip-D, Takey, Tokyo, Japan). Participants in erect stance and with the arm in complete extension were instructed to squeeze the handle as fast and as hard as possible for 5 secs. The test was performed twice (alternately with both hands) with a 1-minute rest between trials, and the maximum value of the four attempts was used. To account for individual differences in body mass [15], we have used relative grip strength (i.e., handgrip strength/body mass, both in kg) for the analysis. The arm-curl test [13] measured upper-body MS, as the number of full curls completed in 30-s with a 3.6-kg dumbbell while seated in a 43.2-cm chair without armrests. The best score of the two attempts (one of each arm) was used. The chair-stand test [13] measured lower-body MS, as the number of full stands from a seated position in 30-s with arms crossed and held against the chest.

Multimedia explanations of all tests, except for Handgrip test, are available on the link below: https://upotv.upo.es/series/58da216a238583e0478b48f0. For each test, the same trained instructor explained the protocol, gave a demonstration prior to start, supervised, verbally encouraged (using standardized encouragements for the 6MWT [13]), and recorded the result.

Anthropometry

The following variables were collected in the morning after an overnight fast. Height was measured with a stadiometer without shoes the nearest 0.1 cm. Weight, fat mass, and fat free mass were measured to the nearest 0.1 kg via bioelectrical impedance analysis (InBody-770, Biospace, Seoul, Korea). Waist circumference (waist) was assessed at the midpoint between the last rib and the iliac crest, and hip circumference at the level of the greater trochanter. Both circumferences were measured twice to the nearest 0.1 cm using a measuring tape (Harpenden Anthropometric Tape; Holtain, Dyfed, UK), and mean values were used. Body mass index (BMI), fat mass index (FMI), fat free mass index (FFMI) (all in kg/m^2), waist-to-height$^{0.5}$ ratio [16] (waist-height$^{0.5}$), waist-to-hip ratio (waist-hip), A Body Shape Index (ABSI) were calculated according to the equations, BMI = weigh/height^2, FMI = fat mass/height^2, FFMI = fat free mass/height^2, waist-height$^{0.5}$ = waist /height$^{0.5}$ (both in cm), waist-hip = waist/hip circumference (both in cm), ABSI = waist/(BMI$^{2/3}$ × height$^{1/2}$) with waist and height expressed in meters and BMI in kg/m^2.

Demographic and other clinical characteristics

Age, diagnoses, illness and prison duration, and medication were obtained from the participants' medical records. Antipsychotic medication was converted into chlorpromazine equivalent dose [17]. The Global Severity Index of the Brief Symptoms Inventory-18 [18] was used to assess psychopathological severity over the past week. Smoking was self-reported.

Intervention

The intervention lasted 12 weeks and included 3 weekly sessions (Monday, Wednesday and Friday) of 45-60 minutes of group-based aerobic and strength exercise. In each session, the two supervisors (JBA and MOAV) first explained (5 minutes) the exercise to be performed during the tasks; were continuously reinforcing exercise techniques, giving positive feedbacks, and encouraging participants to do their best throughout the session; and commending participants for their efforts at the end.

Of the 36 completed sessions, all accompanied by participants preferred music, 27 (75%) were conducted in the gymnasium, including 15 of resistance circuit training and 12 of strength, cycling, and walking training. The remaining 9 sessions (25%) were conducted in an external recreational area of the prison and consisted of aerobic and strength games with minimal material (cones), with 3 of them also including circuit training. The same training method was used as maximum in 2 consecutive sessions.

Resistance circuit training consisted of 3 sets of 8-10 stations of resistance exercises, interspersing 45 seconds to exercise and 15 seconds to change from one station to the next, and 3 minutes rest between sets. Intervals exercise of and transition were respectively controlled by motivational fast-tempo and melodic slow-tempo music interspersed in audio tracks created by the researchers using participants preferred songs. The stations were arranged in a circle, ordered in an alternating upper-body and lower-body exercises, and clearly differentiated by posters with layouts of each exercise placed on the wall. Participants, distributed in pairs or with a supervisor if odd, were asked to select one of the two load levels proposed by the supervisors that better represented a low-intensity load (~30-60% of one repetition maximum) in each station and to perform as many repetitions per exercise as their physical capabilities allow them to maintain a moderate-to-vigorous intensity of exercise throughout the training. Although varied each week, stations typically included exercises such as chest press, shoulder press, squat, bent-over row, arm curl, wall ball, and sit-up using dumbbells, bars and discs, elastic bands, Swiss balls, and 3 kg-medicine balls. Along the 15 sessions, relative load and number of sets remained unchanged, and set duration increased gradually (4 sessions with 8 minutes per set, 3 with 10 minutes, 2 with 12 minutes, 3 with 15 minutes, 2 with 18 minutes, and 2 with 20 minutes). Participants started the second and third sets in the next station where finished the preceded set. Participants re-started the cycle of exercises when sets were longer than 10 minutes.

In resistance, cycling, and walking training sessions the group divided in three subgroups performed separately each type of exercise. Resistance training consisted of 3 sets of 6 repetitions of a 12 repetitions maximum load (~75% of one repetition maximum) at maximal intended concentric velocity in 3 to 6 (from week 9) of aforementioned resistance exercises, and 3 minutes of recovery between sets/exercises. Until week 8, cycling training consisted of moderate-intensity continuous pedaling on stationary bicycle; and from week 9, of high-intensity interval training with 3 all-out efforts of 10, 15, 20, 15, and 10 seconds interspersed with 40 seconds recovery periods by pedaling at low-intensity. Walking training consisted on walking-up and down a 10-meter course marked by cones. Participants started by performing 1-minute sets of varied walking tasks such as normal walking, walking with lunges, walking coordinating varied legs and hands movements, walking fast, without recovery between sets; and followed with an incremental exercise from medium to fast walking speed (reducing 1 second each one or two minutes the time required to complete a course, starting in 8 seconds and using a stopwatch). Both activities were executed with external loads from week 6 with gradually increased (using weighted discs of 0.5 up to 5 kg). Resistance and cycling trainings were always conducted simultaneously by the same supervisor (JBA) and the walking training by the other (MAOV). The total duration of every training mode was the same and increased gradually (15 minutes at first, 18 minutes from week 5, and 20 minutes from week 9).

Circuit training consisted of 3 sets of 12 minutes interspersing 60 seconds of aerobic exercises and 30 seconds of resistance exercises without external loads, and 3 minutes rest between sets. Intervals of resistance exercises and aerobic exercises were controlled respectively by motivational fast-tempo and melodic slow-tempo music as explained before.

Exercise duration and intensity were monitored throughout with the SenseWear WMS Mini armband (BodyMedia Inc., Pittsburgh, PA, USA), which combines triaxial-accelerometry with measurements of heat production and skin conductivity, to accurately estimate energy expenditure during aerobic, resistance, and combined exercise [19]. All attendants wore the device on their left arm triceps muscle while training. Time in total (>1.5 METs), light (>1.5-3 METs), moderate-to-vigorous (>3-9 METs), and very vigorous (>9 METs) exercise were derived using manufacturer-specific algorithms (SenseWear Professional software version 8.1; BodyMedia, Inc., Pittsburgh, PA, USA).

Usual care

Usual care consisted of psychotherapy, pharmacological treatments, and group therapy (cognitive, educational, and creative/recreational activities such as painting and reading) facilitated by psychologists and social workers.

Statistical analysis

Analyses were performed on intention-to-treat (ITT) and per protocol (PP) bases. ITT included all randomised participants who provided baseline and follow-up data for every outcome measure. PP analyses included participants who attended at least 70% of the exercise sessions and the entire control group. Between-group comparisons of baseline demographic and clinical characteristics were performed using unpaired *t*-tests (Student's for ITT and Welch's for PP), Mann-Whitney *U* test, Chi-square test, or Fisher's exact test, according to the nature and distribution of variable. Within-group comparisons of fitness and anthropometric measures were analysed by paired Student's *t*-test or Wilcoxon's signed-rank test. Between-group comparisons of the percent change in fitness and anthropometric measures were performed using unpaired *t*-tests (Student's or Welch's) and Mann-Whitney *U* test. These tests were carried out using SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp) and adjustments for multiple comparisons were made using the Bonferroni method by dividing the significance level of 0.050 by the number of comparisons. Data was also assessed for practical/clinical meaningfulness using an approach based on the magnitudes of change. Cohen's *d* statistic determined the effect size (ES) of the standardized differences in the selected variables, and Hopkins' scale [20] and a customized spreadsheet [21] for determining the magnitude of the ES was used. A practically worthwhile difference was assumed when the difference score was at least 0.2 of the between subject SD. Threshold values for ES were trivial (0.0–0.19), small (0.2–0.59), moderate (0.6–1.1), large (1.2–1.9), and very large (>2.0). Quantitative chances of positive/trivial/negative difference were assessed qualitatively as follows: <25% unclear, 25 to 75% possibly, >75% likely, >95% very likely, and >99% almost certainly. A substantial difference was set at >75%.

Results

Forty-one of the 43 (95.3%) individuals enrolled by the medical staff were eligible and randomized (control=20, intervention=21), and 39 (95.1%) completed baseline and follow-up assessments (control=20, intervention=19) (Figure 1). Ten dropouts were reported (24.4%), all in the intervention group, including 4 voluntary dropouts (all due to disinterest in exercise). The remaining 11 participants from the intervention group had an attendance rate of 77%, or 28 of 36 sessions (range, 8-35), and a persistence rate of 93%, or 11 of 12 weeks (range, 7-12), with the majority (9 of 11) attending at least 70% (referred to as 'compliance intervention group' henceforth). Reasons for missed sessions were temporary exit from prison (29%) [due to permission (50%), participation in external activities organized by local mental health associations (38%), trial attendance (12%)], conflicting schedules with training courses/prison work (24%), mental ill health (18%), physical ill health (11%), unknown (11%), and unspecified (7%). No adverse events occurred during the study for either the intervention or the control group.

A mean of 10.5 ± 2.3 participants (range, 6-16) from the intervention group attended each session. None of them refused to wear the SenseWear and only 3 out of 345 records (0.9%) were excluded due to technical errors. Mean session duration was 49.6 ± 12.9 minutes (range, 24-66), with 44.0 ± 12.3 minutes (range, 23-61) of exercise, accumulated in 13.2 ± 6.6 (range, 2-30) minutes of light, 30.8 ± 10.0 minutes (range, 19-50) of moderate-to-vigorous, and 0.6 ± 0.8 (range 0-3) minutes of very vigorous exercise.

Participants' characteristics are summarized in Table 1. The control group had substantially lower prison duration than the intervention group (ES = -0.48 [90%CL: ± 0.52], small; P = 0.126) and substantially higher age than the compliance intervention group (ES = 0.69 [90%CL: ± 0.65], moderate; P = 0.082). The compliance intervention group had substantially lower age (ES = -0.97 [90%CL: ± 0.75], moderate; P = 0.029) and illness duration (ES = -1.10 [90%CL: ± 0.69], moderate; P = 0.013) compared to the non-compliance intervention group.

Table 2 shows baseline and changes in fitness and anthropometric measures within-groups. At baseline, the control group exhibited substantially worse mean values for all fitness (ES ranged from -0.64 to -1.11, moderate) and all but two (weight and FFMI) anthropometric parameters (ES ranged from 0.45 to 0.69, small- to moderate) compared with the intervention group. Statistical significance was reached for handgrip strength (P = 0.002). Compared with the compliance intervention group, the control group showed substantially worse results for all parameters (ES ranged from 0.53 to 0.97, small- to moderate), being significant for the arm-curl test (P <0.001). At follow-up, the control group substantially reduced the waist-hip (-3.4%, small ES), whereas the intervention group substantially improved the 6MWT (+9.2%, moderate ES), ISWT (+29.0%, moderate ES), Arm-Curl test (+9.5%, small ES), waist (-3.6%, small ES), waist-height$^{0.5}$ (-1.8%, small ES), waist-hip (-5.8%, moderate ES), and ABSI (-2.9%, moderate ES). Statistical significance was reached for waist-hip (both in the control and the intervention groups), ISWT, waist, and ABSI (all *P* <0.004). The compliance intervention group substantially improved all reported parameters for the intervention group, but with greater change differences and ES values (except for waist-height$^{0.5}$), and with large-size effects rather than moderate for 6MWT and waist-hip. Furthermore, the Chair Stand test substantially improved (+9.8%, moderate ES). Statistical significance was reached for waist-hip (*P* <0.001).

Table 3 shows the main benefits of the intervention for fitness and anthropometric parameters in the ITT and PP. Between-group change differences substantially favoured the intervention group on 6WMT (ITT = +12.5%, moderate ES; PP = +21.2%, large ES), ISWT (ITT = +25.6%, moderate ES; PP = +33.9%, large ES), Arm Curl test (PP = +13.8%, moderate ES), weight (PP = -6.9%, moderate ES), waist (ITT = -2.9%; PP = -3.5%, both moderate ES), waist-height$^{0.5}$ (ITT = -1.4%, moderate ES; PP = -1.7%, small ES), waist-hip (ITT = -2.3%, small ES; PP = -3.4%, moderate ES), and ABSI (ITT = -2.3%; PP = -3.3%, both moderate ES). No significant differences were found for either ITT or PP.

Additional analysis showed that the number of participants with low handgrip strength (<25th percentile of age- and gender-normative data from the NHANES study [15]) increased in the control group (from 4 to 7) and decreased in the intervention group (from 2 to 0, both of the compliance group). Furthermore, the improvement in the chair stand test in the compliance intervention group was strongly associated (r(9) = 0.80, *P* = 0.010) with total time engaged in moderate-to-vigorous exercise during sessions, and coefficients remained unchanged (r(9) = 0.88, *P* = 0.004) when controlled (partial correlation) attendance (supplementary material 1).

Discussion

The major finding of the present study was that, despite its relatively short duration (12 weeks), an intervention combining aerobic and strength exercises performed by psychiatric men inmates produced substantial benefits in CRF, upper-body MS, and several anthropometric parameters. Furthermore, additional analysis suggested beneficial effects of exercise in handgrip and lower-body MS. All previous exercise-based-intervention peer-review studies [22-29] in prison also used supervised exercise, including combined exercise [22-25] and yoga [26-29], as the sole component of the intervention, but none focused exclusively in psychiatric inmates. Therefore, the current study adds new insights to the scientific literature.

Our rates of attendance (77%) and exercise dropout (48%) were similar to those reported in previous studies of combined exercise in prison which ranged from 57 to 75% [22, 24, 25] and from 12 to 50% [22-25], respectively. Interestingly, all of these studies were randomized controlled trials of group-based interventions in men, and one [23] included psychiatric inmates (two with depression and in the control group). Additionally, the studies that administered combined exercise as the sole intervention component in people with SMI of the general community reported lower dropout (ranging from 0 to 36%) [30-37] and similar attendance rates (ranging from 71 to 85%) [30, 31, 33, 37], with the exception of one study with lower attendance (37%) [35] and other [36] that presents the best attendance (97%) in the literature on exercise in people with SMI. Collectively and adding the absence of adverse events, our intervention in psychiatric men inmates was safe and overall as feasible as the previously implemented in prison and among people with SMI of the general community.

The feasibility results may have been positively influenced by several aspects associated with reduced dropouts in people with SMI [5, 38, 39], including (i) to implement a group-based intervention of (ii) moderate-to-high intensity exercise (iii) delivered by exercise professionals and (iv) supervised throughout the duration of intervention. Other factors could have increased the attractiveness, enjoyment, and tolerability of the intervention, and therefore the participation, such as (i) the use of participant's preferred music [40] and (ii) the variation of training sessions (comprising training methods, exercise selection, exercise equipments, and settings where exercise was performed). On the other hand, the combined exercise training may have negatively influenced the feasibility results because is associated with greater dropout rate compared with aerobic or strength training alone in people with SMI [38, 39], however, all dropouts and missed training sessions were unrelated to the intervention. Finally, given that all voluntary dropouts were due to disinterest in exercise, a common barrier towards exercise in people with SMI [41], future exercise-based interventions should include more strategies to improve adherence and reduce dropout rates. For example, more targeted and tailored approaches towards participant preference (rather than offering only general classes), as recently suggested by Firth et al [34].

The simultaneous improvement in CRF and MS at follow-up can be considered a potentially clinically relevant finding because the combination of high CRF and high MS have additive effects on reduced risk of mortality [42] in men even among those with normal-weight. Although mutual benefits may be primarily due to the type of exercise implemented, other reasons may have moderated these changes. For example, at least a weekly session included resistance circuit-based training using low-intensity (~30-60 of one repetition maximum) exercises and lasting 24-60 minutes, an effective training method for the concurrent development of CRF and MS in healthy adults [43]. Furthermore, to implement an intervention with 3 weekly sessions and supervised by qualified exercise personnel may have also contributed to maximize CRF, concurring with a recent meta-analysis in people with SMI [5, 44]. Concerning MS, the improvements may be also explained because a third of sessions included resistance exercises of moderate intensity (~75% of one repetition maximum) performed at maximal intended concentric velocity and moderate volume (50% of the maximum number of possible repetitions), that elicits higher enhancements in MS than moderate-slow resistance training [45] and low and high volumes [46], respectively.

The intervention provided substantial improvements in 5 out of the 8 anthropometric parameters, being the benefits in ABSI and waist-height$^{0.5}$ the most clinically interesting findings, as explained below. ABSI is a better predictor of all-cause, cardiovascular, and cancer mortality compared with BMI, waist, waist-to-height ratio and waist-hip [10]. Waist-height$^{0.5}$ outperformed BMI, waist, waist-hip, ABSI, and waist-to-height ratio in predicting cardiometabolic risk [16]. Consequently, these improvements might have contribute to closing the life expectancy gap and reducing cardiometabolic risk, two critical health issues in people with SMI [1, 2].

Finally, our finding that combined exercise improves simultaneously fitness and anthropometric parameters is in line with all studies [22, 23, 25] that compared combined exercise to control group in prison inmates and with all [38, 39] but one [30] in people with SMI of the general community. Although these results are highly promising, given the relevance for health of both outcomes through the lifespan [47], a huge amount of research sustains that improving fitness may be relatively more important [47]. However, the "fitness vs fatness" still requires further investigation [47] and future studies should explore whether exercise-induced improvements in fitness and fatness lead to independent or interactive improvements on health.

Strengths and limitations

The study had several strengths. First, the entire intervention was designed, implemented and supervised by exercise physiologists. Second, duration and intensity of exercise of all participants who attended exercise sessions were monitored by a multisensory-activity monitor to accurately estimate energy expenditure during aerobic, resistance, and combined exercise [19]. Additionality and according to a recent review [19], measurement errors were minimized because we used the latest available model and proprietary algorithms, and less than 1 minute per session were of very vigorous intensity (>9 METs). Third, we used relatively new and promising measures to estimate CRF (distance walked in ISWT), mortality (ABSI), and cardiometabolic risk (waist-height$^{0.5}$), which had not been employed in inmates or people with SMI up to date. Moreover, this is the first time that waist-height$^{0.5}$ was used in a follow-up study. Finally, we prioritized the use of magnitude-based inference because of the advantages over null-hypothesis significance testing: more intuitive interpretation, smaller required sample sizes, higher rates of publication-worthy findings and less publication bias [48]. However, as occurs with null-hypothesis significance testing [49], the use of MBI is not free of criticisms [49]. In any case, practitioners and the scientific community should consider the practical/clinical meaningfulness rather than just statistical significance.

Limitations include the sample of men predominately (65.9%) diagnosed with personality disorder that may restrict the generalizability of current findings. However, the prison where the intervention took place is exclusively for men and the percentage was the same reported (65%) in a systematic review of prison populations in western countries [50]. The exercise dropout rate was high (48%) and only 9 out of 21 (42%) intervention participants attended at least 70% of sessions. However the rates of recruitment (95.3%) and completion of baseline and follow-up assessments (95.1%) were nearly perfect and, anecdotally, 3 participants had promising attendance and persistence rates when dropped out involuntarily. Specifically, one dropped at week 5, having an attendance rate of 64.3% (9 out of 14 possible sessions) and a persistence rate of 100% (5 out of 5 possible weeks); other at week 7, having rates of 85% (17/20) and 100% (7/7); and the remaining, at week 9, having rates of 69.2% (18/26) and 88.9% (8/9). Nonetheless, as beforementioned, more efforts are necessary to increase adherence to exercise in future interventions. The assessment of CRF using an indirect measurement of two submaximal tests (distance walked in 6MWT and ISWT) could be considered another limitation. Interestingly, although both measures showed a very large association at baseline (r(40) = 0.80; $P < 0.001$; supplement 1 shows all correlations between baseline fitness and anthropometric measures), the association between changes was moderate (r(34) = 0.41; $P = 0.016$; supplement 2 shows all correlations between changes in fitness and anthropometric measures) which means that the change in one test explained just 19% ($r^2 = 0.19$) of the variance of the other, suggesting therefore that both tests appear to measure different constructs. The differences between protocols may explain this controversy. In this sense, because the externally-paced incremental protocol of ISWT is similar to the laboratory test to determine maximal oxygen uptake (the gold standard for CRF assessment) one may hypothesize that ISWT can be a more promising test of CRF than 6MWT. Nonetheless, longitudinal criterion validity studies are required to check whether both field tests are able to detect changes in maximal oxygen uptake.

Conclusion

In conclusion, a 12-week group-based intervention of supervised aerobic and strength exercise training was safe, feasible, and effective for improving fitness and anthropometric parameters in psychiatric men inmates. Although much remains to be done in this field, the current study showed promising results and could help to raise health professionals' awareness of the importance of considering exercise as medicine in prison environments, where the disproportionate burden of SMI in inmates represents both a challenge and an opportunity for public health and the scientific community.

Declarations of interest

None.

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Table 1. Characteristics of the participants.

	All (n = 41)	Control (n = 20)	Intervention (n = 21)	Compliance (n=9)	Non-compliance (n=12)
Age (years)	38.2 ± 9.2	39.3 ± 10.1	37.1 ± 8.3	32.7 ± 8.4	40.4 ± 6.7
Illness duration (years)	12.0 ± 10.5	11.7 ± 11.3	12.3 ± 9.8	6.8 ± 4.1	16.4 ± 10.9
Prision duration (years)	2.6 ± 2.5	1.9 ± 1.3	3.3 ± 3.2	2.9 ± 3.3	3.7 ± 3.3
Chlorpromazine equivalent dose (mg/day)	674.3 ± 551.4	789.7 ± 661.9	564.4 ± 407.4	569.3 ± 390.3	560.7 ± 437.0
Psychopathological severity (0-72)[a, b]	2.8 ± 2.9	3.4 ± 3.5	2.2 ± 2.1	2.1 ± 2.2	2.4 ± 2.1
Smoking (current smoker)	32 (78.0)	18 (90.0)	14 (66.7)	8 (88.9)	6 (50.0)
Diagnoses					
Schizophrenia, schizotypal and delusional disorders	2 (4.9)	2 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mood [affective] disorders	1 (2.4)	0 (0.0)	1 (4.8)	0 (0.0)	1 (8.3)
Disorders of adult personality and behaviour	27 (65.9)	13 (65.0)	14 (66.7)	6 (66.7)	8 (66.7)
Neurotic, stress-related and somatoform disorders	5 (12.2)	2 (10.0)	3 (14.3)	1 (11.1)	2 (16.7)
Mental retardation	4 (9.8)	1 (5.0)	3 (14.3)	2 (22.2)	1 (8.3)
Disorders due to psychoactive substance use	2 (4.9)	2 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)

NOTE. Values are the mean ± SD or n (%). Compliance included participants who attended at least 70% of the exercise sessions. Non-compliance included participants who dropped out (n = 10) and who attended less than 70% of the exercise sessions (n = 2).

[a]Missing data. Reasons: Incomplete questionnaire data for Psychopathological severity (control n = 2; intervention n = 2, both of the non-compliance group).

[b]Psychopathological severity was assessed using the Brief Symptoms Inventory-18, with higher scores indicating greater severity.

Table 2. Baseline and within-group comparisons in change from baseline to follow-up in fitness and anthropometric measures.

	n	Baseline	Change (%)	Statistics		
		M ± SD	M ± SD	ES (90 % CL)[a]	Qualitative[b]	*P*
6-min walk test (m)[c]						
Control	18	577.8 ± 60.5	-3.3 ± 9.5	-0.32 (0.35)	Possibly, 1/27/72	0.130
Intervention	16	651.9 ± 61.6	9.2 ± 18.7	0.95 (0.85)	Likely, 93/6/2	0.068
Compliance	9	667.0 ± 73.5	17.9 ± 20.7	1.47 (1.06)	Very likely, 97/2/1	0.032
Incremental Shuttle Walking Test (m)[c]						
Control	18	484.4 ± 156.7	-3.4 ± 19.9	-0.08 (0.23)	Likely, 2/79/19	0.523
Intervention	16	624.4 ± 176.4	29.0 ± 32.5	0.93 (0.49)	Very likely, 99/1/0	0.004
Compliance	9	697.8 ± 201.1	34.2 ± 42.3	1.05 (0.69)	Very likely, 98/2/0	0.021
Relative handgrip strength[c,d]						
Control	20	0.533 ± 0.089	5.2 ± 13.8	0.22 (0.34)	Possibly, 55/43/2	0.157
Intervention	18	0.625 ± 0.091	3.9 ± 8.7	0.28 (0.24)	Possibly, 72/28/0	0.058
Compliance	9	0.596 ± 0.109	3.1 ± 10.7	0.17 (0.33)	Possibly, 42/54/4	0.374
Arm-curl test (repetitions)[c]						
Control	19	27.6 ± 6.4	-2.2 ± 19.3	-0.03 (0.29)	Possibly, 9/75/16	0.852
Intervention	18	32.1 ± 5.3	9.5 ± 16.9	0.49 (0.38)	Likely, 89/10/0	0.041
Compliance	9	34.9 ± 5.9	16.0 ± 15.8	0.75 (0.49)	Very likely, 96/3/0	0.023
Chair-stand test (repetitions)[c]						
Control	18	24.0 ± 6.0	4.3 ± 21.6	0.05 (0.33)	Possibly, 22/68/10	0.784
Intervention	17	29.3 ± 5.3	6.3 ± 14.6	0.31 (0.31)	Possibly, 72/27/1	0.102
Compliance	9	32.0 ± 4.0	9.8 ± 9.3	0.66 (0.40)	Very likely, 97/3/0	0.015
Weight (kg)						
Control	20	89.6 ± 18.4	-0.3 ± 6.6	-0.01 (0.12)	Very likely, 0/99/1	0.838
Intervention	19	84.3 ± 11.2	-2.1 ± 3.3	-0.15 (0.09)	Possibly, 0/80/20	0.011
Compliance	9	81.7 ± 8.8	-1.6 ± 4.0	-0.13 (0.20)	Possibly, 1/71/28	0.258
BMI (kg/m^2)						
Control	20	30.3 ± 4.7	-0.4 ± 6.6	-0.04 (0.17)	Likely, 1/93/5	0.725
Intervention	19	28.2 ± 3.6	-2.1 ± 3.2	-0.16 (0.10)	Possibly, 0/75/25	0.008
Compliance	9	27.5 ± 3.7	-1.5 ± 3.8	-0.10 (0.16)	Likely, 0/85/5	0.256
FMI (kg/m^2)						
Control	20	9.4 ± 3.8	4.8 ± 19.8	0.05 (0.19)	Likely, 9/90/2	0.680
Intervention	19	7.2 ± 2.6	-3.0 ± 22.6	-0.14 (0.19)	Possibly, 0/70/30	0.237
Compliance	9	6.3 ± 2.6	-0.1 ± 32.2	-0.04 (0.35)	Unclear, 12/67/21	0.834
FFMI (kg/m^2)						
Control	20	20.9 ± 2.0	-1.8 ± 4.5	-0.18 (0.17)	Possibly, 0/57/43	0.076
Intervention	19	21.1 ± 1.9	-1.4 ± 3.2	-0.17 (0.16)	Possibly, 0/61/39	0.070
Compliance	9	21.2 ± 2.0	-1.6 ± 4.5	-0.18 (0.29)	Possibly, 2/53/45	0.284
Waist (cm)[c]						
Control	20	103.9 ± 13.0	-0.7 ± 6.5	-0.06 (0.20)	Likely, 2/86/12	0.605
Intervention	18	97.3 ± 8.9	-3.6 ± 4.0	-0.37 (0.17)	Likely, 0/5/95	0.002
Compliance	9	93.8 ± 8.5	-4.1 ± 4.8	-0.40 (0.30)	Likely, 0/12/88	0.037
WHT5R[c,e]						
Control	20	0.778 ± 0.059	-0.4 ± 3.3	-0.07 (0.20)	Likely, 2/85/13	0.835
Intervention	18	0.749 ± 0.050	-1.8 ± 2.0	-0.39 (0.19)	Very likely, 0/4/96	0.059
Compliance	9	0.733 ± 0.050	-2.1 ± 2.4	-0.44 (0.32)	Likely, 0/10/90	0.317
Waist-hip[c]						
Control	20	1.012 ± 0.063	-3.4 ± 4.4	-0.55 (0.27)	Very likely, 0/2/98	0.002
Intervention	18	0.981 ± 0.046	-5.8 ± 3.4	-1.19 (0.29)	Almost certainly, 0/0/100	< 0.001
Compliance	9	0.961 ± 0.034	-6.8 ± 3.4	-1.75 (0.54)	Almost certainly, 0/0/100	< 0.001
ABSI[c]						
Control	20	0.819 ± 0.037	-0.6 ± 3.0	-0.13 (0.25)	Possibly, 2/66/32	0.372
Intervention	18	0.798 ± 0.029	-2.9 ± 3.6	-0.77 (0.38)	Very likely, 0/1/99	0.003
Compliance	9	0.792 ± 0.031	-3.9 ± 3.6	-0.89 (0.52)	Very likely, 0/2/98	0.013

NOTES. Change calculated as [(follow-up - baseline)/baseline] × 100. Paired Student's *t*-test test was used to compare baseline and follow-up measures, except for WHT5R (control, intervention and compliance). Wilcoxon's signed-rank test was used in these three cases. Compliance included participants who attended at least 70% of the exercise sessions. Anthropometric indices calculated according to the equations, BMI = weigh/height^2, FMI = fat mass/height^2, FFMI = fat free mass/height^2, waist-height$^{0.5}$ = waist /height$^{0.5}$ (both in cm), waist-hip = waist/hip circumference (both in cm), ABSI = waist/(BMI$^{2/3}$ × height$^{1/2}$) with waist and height expressed in meters and BMI in kg/m^2.

Abbreviations: ABSI: A Body Shape Index; BMI: Body mass index; CL: confidence limit; ES: effect size; FFMI: fat free mass index; FMI: fat mass index; Waist: waist circumference; Waist-hip: waist-to-hip ratio; WHT5R: waist-to-height$^{0.5}$ ratio.

Substantial when the chance of positive/trivial/negative >75%.
Significant when P < 0.004 (i.e., 0.05/13 comparisons = 0.004).
[a]Threshold values for Cohen's ES were trivial (0.0–0.19), small (0.2–0.59), moderate (0.6–1.1), large (1.2–1.9), and very large (>2.0).
[b]Quantitative chances of positive/trivial/negative difference were assessed qualitatively as follows: <25% unclear, 25 to 75% possibly, >75% likely, >95% very likely, and >99% almost certainly.
[c]Missing data. All were missing data from the follow-up except for one case in which a participant refused to perform the 6-min walk test and Incremental Shuttle Walking Test both at baseline and follow-up. In all cases participants refused to perform the test except one in which a participant was injured and cannot perform the 6-min walk, Incremental Shuttle Walking, and Chair-stand tests at follow-up.

[d]Handgrip strength/body mass, both in kg.

Table 3. Between-group comparisons in change from baseline to follow-up in fitness and anthropometric measures using intention-to-treat (ITT) and per protocol (PP) analyses.

	n		Difference (%)	Statistics		
	Control	Intervention	M (90 % CL)	ES (90 % CL)[a]	Qualitative[b]	*P*
6-min walk test[a]						
ITT	18	16	12.5 (8.9)	0.81 (0.58)	Very likely, 96/4/0	0.025
PP	18	9	21.2 (13.3)	1.23 (0.77)	Very likely, 98/1/0	0.015
Incremental Shuttle Walking Test[c]						
ITT	18	16	25.6 (16.0)	1.07 (0.57)	Very likely, 99/1/0	0.005*
PP	18	9	33.9 (24.3)	1.35 (0.65)	Almost certainly, 100/0/0	0.005
Relative handgrip strength[c,d]						
ITT	20	18	-1.4 (6.3)	-0.12 (0.53)	Unclear, 16/44/40	0.714
PP	20	9	-2.1 (8.2)	-0.16 (0.64)	Unclear, 17/37/46	0.662
Arm-curl test[c]						
ITT	19	18	7.3 (10.1)	0.39 (0.54)	Possibly, 72/24/4	0.233
PP	19	9	13.8 (11.9)	0.76 (0.65)	Likely, 92/7/1	0.060
Chair-stand test[c]						
ITT	18	17	2.0 (10.5)	0.10 (0.56)	Unclear, 39/43/18	0.754
PP	18	9	5.5 (10.2)	0.32 (0.59)	Unclear, 63/29/7	0.367
Weight						
ITT	20	19	-1.4 (6.3)	-0.12 (0.53)	Unclear, 16/44/40	0.289
PP	20	9	-6.9 (5.7)	-0.65 (0.55)	Likely, 1/8/92	0.501
BMI						
ITT	20	19	-1.6 (2.8)	-0.30 (0.53)	Unclear, 6/32/63	0.340
PP	20	9	-1.1 (3.3)	-0.19 (0.60)	Unclear, 14/37/49	0.595
FMI						
ITT	20	19	-7.8 (11.5)	-0.36 (0.53)	Possibly, 4/26/69	0.257
PP	20	9	-4.9 (21.0)	-0.17 (0.75)	Unclear, 19/33/48	0.680
FFMI						
ITT	20	19	0.4 (2.1)	0.09 (0.53)	Unclear, 37/46/18	0.769
PP	20	9	0.2 (3.2)	0.05 (0.68)	Unclear, 35/38/27	0.905
Waist[c]						
ITT	20	18	-2.9 (2.9)	-0.62 (0.53)	Likely, 1/9/91	0.061
PP	20	9	-3.5 (3.7)	-0.70 (0.63)	Likely, 1/8/91	0.099
WHT5R[c]						
ITT	20	18	-1.4 (1.5)	-0.64 (0.53)	Likely, 1/8/92	0.054
PP	20	9	-1.7 (1.9)	-0.58 (0.63)	Likely, 2/13/85	0.128
Waist-hip[c]						
ITT	20	18	-2.3 (2.1)	-0.58 (0.53)	Likely, 1/11/88	0.078
PP	20	9	-3.4 (2.6)	-0.85 (0.64)	Likely, 1/4/95	0.033
ABSI[c]						
ITT	20	18	-2.3 (1.8)	-0.70 (0.54)	Likely, 0/6/93	0.034
PP	20	9	-3.3 (2.5)	-0.95 (0.71)	Very likely, 1/3/96	0.032

NOTES. ITT included all randomised participants who provided baseline and follow-up data for every outcome measure. PP analyses included participants who attended at least 70% of the exercise sessions and the entire control group. Difference calculated as Intervention minus Control in change calculated as [(follow-up - baseline)/baseline] × 100. Unpaired *t*-Student's and Welch's were used for ITT and PP comparisons, respectively, except for Incremental Shuttle Walking Test (ITT and PP), WC (ITT and PP), and WHT5R (ITT). Mann-Whitney *U* test was used in these cases.

Abbreviations: ABSI: A Body Shape Index; BMI: Body mass index; CL: confidence limit; ES: effect size; FFMI: fat free mass index; FMI: fat mass index; Waist: waist circumference; Waist-hip: waist-to-hip ratio; WHT5R: waist-to-height$^{0.5}$ ratio.

Substantial when the chance of positive/trivial/negative >75%.

Significant when $P < 0.004$ (i.e., 0.05/13 comparisons = 0.004).

[a]Threshold values for Cohen's ES were trivial (0.0–0.19), small (0.2–0.59), moderate (0.6–1.1), large (1.2–1.9), and very large (>2.0).

[b]Quantitative chances of positive/trivial/negative difference were assessed qualitatively as follows: <25% unclear, 25 to 75% possibly, >75% likely, >95% very likely, and >99% almost certainly.

[c]Missing data. All were missing data from the follow-up except for one case in which a participant refused to perform the 6-min walk test and Incremental Shuttle Walking Test both at baseline and follow-up. In all cases participants refused to perform the test except one in which a participant was injured and cannot perform the 6-min walk, Incremental Shuttle Walking, and Chair-stand tests at follow-up.

[d]Handgrip strength/body mass, both in kg.

Supplementary material 1. Simple and partial correlations between total time engaged in moderate-to-vigorous exercise during sessions with change in fitness and anthropometric outcomes in the compliance intervention group (n = 9).

	Simple correlation		Partial correlation[a]	
	r	p	r	p
6-min walk test	0.65	0.059	0.63	0.095
Incremental Shuttle Walking Test	0.65	0.058	0.60	0.119
Relative handgrip strength	-0.08	0.841	-0.11	0.804
Arm-curl test	0.40	0.284	0.38	0.356
Chair-stand test	0.80	0.010	0.88	0.004
Weight	0.09	0.810	0.23	0.591
Body mass index	0.08	0.829	0.24	0.574
Fat mass index	-0.15	0.698	-0.11	0.802
Fat free mass index	0.21	0.587	0.36	0.385
Waist circumference	-0.17	0.668	0.11	0.800
Waist-to-height$^{0.5}$ ratio	0.02	0.954	0.09	0.837
Waist-to-hip ratio	0.18	0.648	9.00	0.497
A Body Shape Index	-0.05	0.900	9.00	0.970

NOTES. Change calculated as [(follow-up - baseline)/baseline] × 100.

Significant when $p < 0.050$.

[a]Adjusted for attendance.

Supplementary material 2. Correlations between baseline measures of fitness and anthropometry.

		6MWT	ISWT	Handgrip	Arm-curl	Chair-stand	Weight	BMI	FMI	FFMI	Waist	WHT5R	Waist-hip
ISWT	r	0.80	1										
	P	<0.001											
	n	40	40										
Handgrip	r	0.43	0.20	1									
	P	0.006	0.214										
	n	40	40	41									
Arm-curl	r	0.32	0.22	0.41	1								
	P	0.043	0.169	0.007									
	n	40	40	41	41								
Chair-stand	r	0.46	0.38	0.29	0.58	1							
	P	0.003	0.016	0.064	<0.001								
	n	40	40	41	41	41							
Weight	r	-0.45	-0.45	0.12	0.17	-0.20	1						
	P	0.003	0.003	0.463	0.299	0.208							
	n	40	40	41	41	41	41						
BMI	r	-0.55	-0.55	-0.13	0.02	-0.17	0.87	1					
	P	<0.001	<0.001	0.417	0.907	0.292	<0.001						
	n	40	40	41	41	41	41	41					
FMI	r	-0.51	-0.47	-0.15	0.10	-0.09	0.73	0.92	1.00				
	P	0.001	0.002	0.357	0.541	0.581	<0.001	<0.001	.				
	n	40	40	41	41	41	41	41	41				
FFMI	r	-0.20	-0.24	0.16	0.02	-0.05	0.65	0.62	0.22	1			
	P	0.227	0.131	0.312	0.890	0.774	<0.001	<0.001	0.177				
	n	40	40	41	41	41	41	41	41	41			
Waist	r	-0.62	-0.58	-0.09	0.07	-0.24	0.89	0.92	0.89	0.46	1		
	P	<0.001	<0.001	0.584	0.685	0.137	<0.001	<0.001	<0.001	0.002			
	n	40	40	41	41	41	41	41	41	41	41		
WHT5R	r	-0.50	-0.37	-0.09	0.00	-0.17	0.73	0.76	0.75	0.37	0.87	1	
	P	0.001	0.019	0.560	0.986	0.297	<0.001	<0.001	<0.001	0.018	<0.001	.	
	n	40	40	41	41	41	41	41	41	41	41	41	
Waist-hip	r	-0.37	-0.41	-0.02	0.01	-0.18	0.38	0.46	0.47	0.18	0.64	0.60	1
	P	0.017	0.009	0.909	0.931	0.263	0.014	0.002	0.002	0.271	<0.001	<0.001	
	n	40	40	41	41	41	41	41	41	41	41	41	41
ABSI	r	-0.35	-0.29	-0.18	-0.04	-0.23	0.17	0.17	0.33	-0.22	0.49	0.51	0.74
	P	0.025	0.069	0.270	0.788	0.143	0.297	0.281	0.032	0.171	0.001	0.001	<0.001
	n	40	40	41	41	41	41	41	41	41	41	41	41

NOTE: Pearson's correlation coefficient was to compare fitness and anthropometric measures, except for WHT5R and FMI. Spearman correlation coefficient was use in these cases.

Abbreviations: 6MWT: 6-min walk test; ABSI: A Body Shape Index; BMI: Body mass index; FFMI: fat free mass index; FMI: fat mass index; ISWT: Incremental Shuttle Walking Test; Waist: waist circumference; Waist-hip: waist-to-hip ratio; WHT5R: waist-to-height$^{0.5}$ ratio.

Significant when $P < 0.050$.

Supplementary material 3. Correlations between change in fitness and anthropometric measures.

		6MWT	ISWT	Handgrip	Arm-curl	Chair-stand	Weight	BMI	FMI	FFMI	Waist	WHT5R	Waist-hip
ISWT	r	0.41	1										
	P	0.016	.										
	n	34	34										
Handgrip	r	0.13	0.02	1									
	P	0.473	0.912										
	n	34	34	38									
Arm-curl	r	0.49	0.31	0.35	1								
	P	0.004	0.072	0.033									
	n	34	34	37	37								
Chair-stand	r	0.19	0.11	0.13	0.60	1							
	P	0.286	0.532	0.459	<0.001								
	n	33	33	35	35	35							
Weight	r	0.00	-0.12	0.15	-0.03	0.02	1						
	P	0.980	0.506	0.368	0.864	0.889							
	n	34	34	38	37	35	39						
BMI	r	-0.01	-0.12	0.11	-0.03	0.03	1.00	1					
	P	0.941	0.482	0.508	0.867	0.874	<0.001						
	n	34	34	38	37	35	39	39					
FMI	r	-0.05	-0.06	0.05	0.16	0.01	0.75	0.75	1				
	P	0.761	0.733	0.745	0.340	0.960	<0.001	<0.001					
	n	34	34	38	37	35	39	39	39				
FFMI	r	0.10	-0.13	0.16	-0.21	0.01	0.33	0.32	-0.30	1			
	P	0.571	0.475	0.339	0.220	0.973	0.039	0.049	0.068				
	n	34	34	38	37	35	39	39	39	39			
Waist	r	-0.06	-0.22	0.15	-0.11	0.01	0.87	0.87	0.67	0.24	1		
	P	0.732	0.204	0.364	0.511	0.938	<0.001	<0.001	<0.001	0.151			
	n	34	34	38	37	35	38	38	38	38	38		
WHT5R	r	-0.07	-0.24	0.15	-0.10	0.03	0.87	0.86	0.67	0.24	1.00	1	
	P	0.687	0.180	0.353	0.554	0.878	<0.001	<0.001	<0.001	0.148	<0.001		
	n	34	34	38	37	35	38	38	38	38	38	38	
Waist-hip	r	-0.01	-0.46	0.15	-0.17	-0.16	0.48	0.49	0.33	0.18	0.70	0.70	1
	P	0.961	0.006	0.368	0.303	0.366	0.002	0.002	0.042	0.268	<0.001	<0.001	
	n	34	34	38	37	35	38	38	38	38	38	38	38
ABSI	r	-0.24	-0.33	0.19	-0.18	-0.03	0.38	0.37	0.29	0.07	0.74	0.75	0.69
	P	0.165	0.055	0.250	0.290	0.844	0.018	0.021	0.081	0.687	<0.001	<0.001	<0.001
	n	34	34	38	37	35	38	38	38	38	38	38	38

NOTE: Change calculated as [(follow-up - baseline)/baseline] × 100. Pearson's correlation coefficient was to compare fitness and anthropometric measures, except for 6MWT and ISWT. Spearman correlation coefficient was use in these cases.

Abbreviations: 6MWT: 6-min walk test; ABSI: A Body Shape Index; BMI: Body mass index; FFMI: fat free mass index; FMI: fat mass index; ISWT: Incremental Shuttle Walking Test; Waist: waist circumference; Waist-hip: waist-to-hip ratio; WHT5R: waist-to-height$^{0.5}$ ratio.

Significant when $P < 0.050$.

ESTUDIO 8 [STUDY 8]

Efectos de un programa de ejercicio físico en pacientes con trastorno mental grave: the PsychiActive project.

Bueno-Antequera J.

en Mendoza Berjano R, Santos-Rocha R, Gil-Barcenilla B (coord.). La promoción de la actividad física en la sociedad contemporánea. Madrid, España: Díaz de Santos.

In press

Efectos de un programa de ejercicio físico en pacientes con trastorno mental grave: the PsychiActive project

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RESUMEN:
El trastorno mental grave (TMG) es considerado un serio problema para la salud pública mundial y una de las enfermedades más incapacitantes. Los pacientes con TMG presentan una esperanza de vida muy reducida en comparación con la población general siendo las enfermedades cardiometabolicas y cardiovasculares las principales contribuyentes, resultando imprescindible una mejor prevención y tratamiento de los trastornos metabólicos y problemas de salud asociados.

Respecto a la población general, los pacientes con TMG presentan niveles deficitarios de sedentarismo, actividad física y condición física cardiorrespiratoria, que han demostrado su asociación con el riesgo cardiometabolico en otras poblaciones. Una de las terapias básicas y económicas para pacientes con TMG, dado la pérdida de capacidad funcional y calidad de vida, es la práctica de ejercicio físico. Sin embargo, los escasos estudios aleatorios controlados sobre ejercicio físico en pacientes con TMG presentan importantes limitaciones que necesitan ser mejoradas en futuros estudios.

El presente capítulo pretende mostrar los efectos de un programa de ejercicio físico en presos psiquiátricos. La propuesta se enmarca dentro de la iniciativa titulada “the PsychiActive project” que responde a la necesidad de dar respuesta a los cambios demográficos registrados en las últimas décadas, con el constante incremento en la esperanza media de vida y la aspiración legítima a disfrutar de más calidad de vida y de un mayor nivel de salud, en este caso bajo una enfermedad como el TMG.

El programa de ejercicio físico tuvo efectos sustancialmente favorables al grupo experimental en aspectos directamente relacionados con la calidad de vida y salud, como masa muscular, índice de riesgo de muerte prematura, fuerza de los miembros inferiores y superiores y condición cardiorrespiratoria. Además el grupo experimental mostró una reducción en la presencia de todos factores de riesgo cardiovascular estudiados excepto en glucosa elevada, que se mantuvo sin cambios y aumentó en el grupo control. Estos hallazgos justifican la promoción de programas de ejercicio físico supervisados como tratamiento preventivo de morbilidad y mortalidad en personas con TMG.

Palabras clave: Trastorno Mental Grave; Ejercicio físico; Calidad de vida; Salud.

1. MARCO TEÓRICO

El trastorno mental grave (TMG) es utilizado para definir un extenso grupo de pacientes que sufren una enfermedad mental grave de larga duración, como la esquizofrenia o el trastorno bipolar. La tasa de prevalencia anual de la esquizofrenia y del trastorno bipolar es del 0,33% (1) y del 1% (2), respectivamente. El TMG es considerado un serio problema para la salud pública mundial y una de las enfermedades más incapacitantes (3). Los pacientes con TMG presentan una esperanza de vida muy reducida en comparación con la población general (4, 5) siendo las enfermedades cardiometabolicas y cardiovasculares las principales contribuyentes (6, 7). Un estudio realizado en España ha demostrado que estos pacientes son más propensos a sufrir enfermedades cardiovasculares, como síndrome metabólico (obesidad visceral, dislipemia, hiperglucemia e hipertensión), que la población general (8). El síndrome metabólico y otros problemas de salud habituales en pacientes con TMG suponen un mayor número de hospitalizaciones no psiquiátricas respecto a la población general, lo que implica un alto impacto económico en nuestro país (9, 10).

Una de las terapias sencillas y económicas para pacientes con TMG, dado el estilo de vida sedentario (11), la pérdida de capacidad funcional (12) y función respiratoria (13), calidad de vida (14) y esperanza de vida (15), es mantener un estilo de vida activo (16). A este respecto, las directrices por el US Department of Health, establecen que los individuos adultos, sea cual sea su condición, deberían acumular al menos 150 minutos a la semana de actividad física moderada a vigorosa, por ejemplo, caminar (17). La Asociación Europea de Psiquiatría recomienda seguir estas directrices para mantener un peso corporal saludable y reducir factores de riesgo cardiovascular en pacientes con TMG (18). Sin embargo, estos pacientes incumplen las recomendaciones mínimas de actividad física para la salud (19) y son más sedentarios que la población general (20).

Mantener actividades sedentarias, como estar sentado o tumbado, la mayor parte del día se asocia con un mayor riesgo de morbilidad y todas las causas de muerte independientemente de la actividad física en población general (21). Un reciente meta-análisis encontró que lo pacientes con TMG son significativamente más sedentarios que la población general (22). Considerando los altos niveles de anomalías cardiometabólicas (23, 24) y los efectos negativos del sedentarismo en pacientes con TMG como el incremento de marcadores inflamatorios (25) y la deteriorada función cognitiva (26), reducir el exceso de conductas sedentarias representa una importante estrategia para mantener el estado de salud en esta población.

Otra terapia eficaz para reducir numerosas enfermedades crónicas es el ejercicio físico (27). Los estudios aleatorios controlados de ejercicio físico en pacientes con TMG han descrito resultados positivos sobre capacidad funcional (28-31), factores de riesgo cardiovascular (32-34), síntomas psiquiátricos (28, 29, 34, 35) y calidad de vida (28, 34, 35). Sin embargo, estos escasos estudios aleatorios controlados presentan importantes limitaciones descritas a continuación que necesitan ser mejoradas en futuros estudios.

- Ningún estudio investigó el efecto del ejercicio físico en pacientes con TMG internos en centros penitenciarios. Un reciente estudio (36) afirmó que tres de cada cuatro internos en centros penitenciarios tiene sobrepeso u obesidad, encontrando mayor prevalencia de factores de riesgo cardiovascular asociados a la obesidad como dislipemia, diabetes e hipertensión en aquellos que padecen TMG. Estos hallazgos ponen de manifiesto la necesidad de desarrollar intervenciones basadas en la evidencia para combatir los alarmantes niveles obesidad y problemas de salud asociados en pacientes con TMG internos en centros penitenciarios.

- Ningún estudio incluyó la metodología de entrenamiento en circuito en pacientes con TMG, considerado eficaz para la mejora de capacidad funcional, composición corporal y función pulmonar en diversas poblaciones (37-39). El entrenamiento en circuito consiste en una secuencia consecutiva de ejercicios de fuerza con cargas ligeras que permite alternar los principales grupos musculares para no fatigarlos y una escasa recuperación que permite mantener una adecuada intensidad de trabajo cardiorrespiratorio. Esta metodología de entrenamiento permite trabajar en grupos utilizando poco material, espacio y tiempo, y el tiempo de ejercicio, transición y ritmo de ejecución de los ejercicios puede ser controlado con música, resultando un método sencillo y motivante para el participante que podría ser aplicable en dispositivos de salud mental. Por estos motivos sería interesante desarrollar estudios que analicen los efectos del ejercicio físico mediante entrenamiento en circuito en pacientes con TMG.

- Sólo un estudio utilizó música para mantener la motivación durante las sesiones de entrenamiento (34). La baja asistencia a los programas de ejercicio físico fundamentalmente debido a la falta de interés hacia la práctica deportiva, es característico de pacientes con TMG (40) y representa un serio problema. Más estudios incluyendo elementos que incrementen la motivación y disfrute de las sesiones de entrenamiento de los pacientes con TMG, como el uso de la música (41-43), son necesarios para reducir el abandono y mantener la adherencia durante el programa de entrenamiento y conseguir los beneficios del entrenamiento físico.

- Tan sólo un estudio analizó el efecto del entrenamiento de fuerza en pacientes con TMG (28), lo que hace necesario desarrollar más estudios que analicen los efectos del entrenamiento de fuerza en esta población. Además, este único estudio sólo valoró la fuerza en los miembros superiores y mediante el test de una repetición máxima (1RM) (28). Evaluar la fuerza con un test de 1RM exige medir la máxima carga desplazable en una repetición, con las consecuentes contraindicaciones para la salud y el elevado riesgo de riesgo que ello supone. Un método seguro, económico y accesible para evaluar la fuerza en la práctica clínica es usar test de campo submáximos como los incluidos en la batería Senior Fitness Test que permite determinar la capacidad funcional necesaria para realizar actividades cotidianas de forma independiente y sin la aparición temprana de la fatiga (44). A pesar de ser usada en múltiples poblaciones (45), no tenemos constancia de su aplicación en pacientes con TMG.

Por estos motivos, se pretendió investigar el rol del ejercicio físico en el tratamiento del TMG.

2. METODOLOGÍA

2.1. Contexto en el que surge el programa

El presente programa surge de un proyecto de tesis doctoral dirigida por el director del Grupo de Investigación Actividad Física y Salud CTS-948 de la Universidad Pablo de Olavide de Sevilla (España) titulado “Niveles de gasto energético, condición física y calidad de vida relacionada con la salud en enfermedad mental”. Tras revisar científicamente la baja esperanza de vida, elevada prevalencia de obesidad, síndrome metabólico y otros factores de riesgo cardiovascular, así como la deficitaria calidad de vida y capacidad funcional de los pacientes con TMG, investigadores del Grupo de

Investigación Actividad Física y Salud CTS-948 de la Universidad Pablo de Olavide consideraron la gran potencialidad y necesidad de este colectivo para beneficiarse de los efectos del ejercicio físico y de estilos de vida activos. Por estos motivos y dada la escasa investigación realizada sobre los efectos del ejercicio físico en este colectivo afrontamos el reto científico de analizar los efectos del ejercicio físico en población con TMG.

El presente programa se enmarca dentro de la iniciativa titulada “the PsychiActive project” que responde a la necesidad de dar respuesta a los cambios demográficos registrados en las últimas décadas, con el constante incremento en la esperanza media de vida y la aspiración legítima a disfrutar de más calidad de vida y de un mayor nivel de salud, en este caso bajo una enfermedad como el TMG. El conocimiento generado en este ámbito debe permitir una auténtica transformación en nuestra manera de entender la enfermedad y sus bases biológicas, repercutiendo en el marco sobre el que desarrollar intervenciones preventivas y terapéuticas efectivas para poder luchar contra ella, tanto a nivel individual como a nivel colectivo.

Los destinatarios de la intervención fueron presos con TMG internos del Hospital Psiquiátrico Penitenciario de Sevilla (España). El programa fue diseñado, ejecutado y supervisado por profesionales en Ciencias de la Actividad Física y del Deporte que pertenecen al Grupo de Investigación Actividad Física y Salud CTS-948 de la Universidad Pablo de Olavide. El apoyo de la coordinación técnica, sanitaria y de seguridad del Hospital Psiquiátrico Penitenciaria fue de gran ayuda para el correcto desarrollo del programa.

2.2. Diseño

Se realizó un estudio aleatorio controlado (*Randomized Controlled Trial* ó RCT), siguiendo las recomendaciones de la *Consolidated Standars of Reported Trials* (CONSORT) (46) presos psiquiátricos del Hospital Psiquiátrico Penitenciario de Sevilla (España), que fueron distribuidos en grupos experimental y control. El periodo de intervención (entrenamiento combinado: aeróbico + fuerza) tuvo una duración de 12 semanas. La valoración previa al periodo de entrenamiento se realizó una semana antes e incluyó, registro de medidas antropométricas y capacidad funcional. En día diferente, se realizó una toma de muestras sanguíneas para medida de glucosa, colesterol y triglicéridos Esta valoración se repitió completa al final del periodo de entrenamiento. Tanto en el grupo control como en el experimental realizaron las mismas valoraciones iniciales y finales. El protocolo del estudio obtuvo la aprobación del Comité de los Hospitales Universitarios Vírgen Macarena y Virgen del Rocío (1674-N-17) y del Ministerio del Interior de España.

2.3. Objetivos del programa

Mejorar aspectos directamente relacionados con la calidad de vida y salud en presos psiquiátricos.

2.4. Sistema de evaluación

2.4.1. Medidas antropométricas

La composición corporal se valoró mediante Impedancia Bioeléctrica Multifrecuencia y segmental directa (Inbody 770, Biospace, South Korea) y los perímetros de cintura y cadera con una cinta métrica (Harpenden anthropometric tape, Holtain Ltd). Se calcularon diversos índices antropométricos considerados factores de riesgo cardiovascular: (i) índice de masa corporal, (ii) índice cintura-cadera, (iii) índice cintura-altura e (iv) índice ABSI (A Body Shape Index) descrito en otra parte (47). Según organismos internacionales de salud pública y otras citas de referencia (48-51) se consideraron factores de riesgo las siguientes valores para cada variable: índice de masa corporal ≥ 25 Kg/m2; porcentaje masa grasa ≥ 25%; perímetro cintura ≥ 102 cm; índice cintura-cadera ≥ 0.9; índice cintura-altura ≥ 0,5; glucosa ≥ 126 mg/dL; colesterol ≥ 200 mg/dL y triglicéridos ≥ 150 mg/dL.

2.4.2. Capacidad funcional

Se utilizaron tres pruebas de la batería Senior Fitness Test descritas en otra parte (52): (i) Arm curl test para evaluar la fuerza del tren superior, (ii) 30-s chair stand test para la fuerza del tren inferior y (iii) test de caminar 6 minutos para la condición cardiorrespiratoria. La información sobre la descripción de la ejecución y e interpretación de las tres pruebas puede ampliarse mediante el siguiente enlace del Laboratorio Multimedia de la Universidad Pablo de Olavide: https://upotv.upo.es/series/58da216a238583e0478b48f0

2.4.3. Muestras sanguíneas

El personal sanitario del Hospital Psiquiátrico Penitenciario de Sevilla tomó muestras sanguíneas en ayuno para valorar los niveles de glucosa, colesterol y triglicéridos.

2.5. Programa de entrenamiento

El grupo experimental recibió un tratamiento que consistió en 3 día/semana (60 minutos/sesión) de ejercicio físico mediante entrenamiento combinado (ejercicios de tipo aeróbico + fuerza) durante 12 semanas.

El programa desarrolló todos los grandes grupos musculares del cuerpo. Al menos una sesión/semana, todo el grupo realizó al mismo tiempo entrenamiento en circuito aérobico de fuerza compuesto por estaciones (o ejercicios) con soporte musical. La música marcó el tiempo de trabajo por estación, transición entre estaciones y ritmo de ejecución de los ejercicios. Al menos una sesión/semana, el grupo se dividió en dos grupos para realizar ejercicios aeróbicos y de fuerza por separado. Un grupo realizó primero los ejercicios de aeróbicos y después los de fuerza y viceversa. Los ejercicios aeróbicos se realizaron caminando/pedaleando (en bicicleta estática) manteniendo/variando la velocidad, o caminando con diferentes tipos de desplazamientos. Los ejercicios de fuerza se realizaron desplazando las cargas a la máxima velocidad de ejecución posible durante la fase concéntrica de movimiento y a velocidad controlada durante la fase excéntrica del movimiento. Para los ejercicios de fuerza se utilizaron mancuernas, barras, discos, balones medicinales, bandas elásticas, espalderas o el propio peso corporal.

Todas las sesiones fueron dirigidas y supervisadas por dos licenciados en Ciencias de la Actividad Física y el Deporte. Para tratar reducir la tasa de abandono y mantener la adherencia al programa, todas las sesiones fueron acompañadas de música y algunas incluyeron formas jugadas y deportes adaptados.

Al grupo control se le pidió que mantuviera su estilo de vida habitual durante el periodo de intervención. Una vez finalizado el periodo de entrenamiento del estudio, los participantes asignados inicialmente al grupo control ejecutaron el mismo programa de entrenamiento utilizado en el grupo experimental.

3. LOGROS ALCANZADOS

Para este estudio se analizaron 52 participantes distribuidos en grupo control (n = 26) y experimental (n = 26), considerando en éste último a aquellos que asistieron al menos al 50% de la sesiones de ejercicio físico.

Considerando el tamaño muestral y la magnitud de los cambios esperados utilizamos el tamaño del efecto de Cohen considerado un método estadístico adecuado ampliamente utilizado en las Ciencias de la Actividad Física y el Deporte (54, 55). Los resultados fueron presentados como la media (±SD), porcentaje de cambio y magnitud de las diferencias o tamaño del efecto de Cohen. Los valores para considerar el tamaño del efecto fueron: trivial (0,0 – 0,19), pequeño (0,2 – 0,59), moderado (0,6 – 1.1), largo (1,2 – 1,9) y muy largo (>2,0) (54, 55). Las probabilidades cuantitativas de diferencia positiva/trivial/negativa se evaluaron cualitativamente de la siguiente manera: <25% improbable, 25 a 75% posible,> 75% probable,> 95% muy probable y >99% casi con certeza. Se consideró un cambio sustancial cuando la posibilidad de positivo/trivial/negativo fue >75%. Por último, se contabilizó el número de participantes que presentaban cada factor de riesgo cardiovascular antes y después del periodo de intervención.

Tras el periodo de intervención se encontraron sustancialmente favorables al grupo exeperimental en masa muscular, ídice ABSI, Arm Curl Test, Chair Stand Test y Test 6 minutos (Tabla 1). También se observó una reducción de la presencia de todos factores de riesgo cardiovascular tras el periodo de intervención en el grupo experimental, salvo para glucosa elevada (Tabla 2). Esta variable se mantuvo sin cambios en el grupo experimental y aumentó su presencia en el grupo control, lo que sugiere efectos positivos del ejercicio en esta variable. Las variables que tuvieron un mayor descenso fueron: perímetro de cintura, índice cintura-cadera, colesterol y triglicéridos (Tabla 2).

[INSERTAR TABLA 1]

[INSERTAR TABLA 2]

4. ANÁLISIS DE LAS FORTALEZAS-DEBILIDADES Y OPORTUNIDADES DE MEJORA FUTURA

El programa presenta varias fortalezas. Dada su sencillez, todas las evaluaciones podrían ser realizadas por el personal sanitario tras un periodo de aprendizaje. Además no requieren material sofisticado tecnológicamente ni costoso econmómicamente, excepto para la evaluación de la composición corporal. Una cinta métrica, una mancuerna y un cronómetro serían suficientes. Los autores están a disposición de todo aquel interesado en ampliar la información sobre las pruebas de evaluación así como del programa de ejercicio físico desarrollado. La información sobre la descripción de la ejecución y e interpretación de las pruebas de capacidad funcional puede ampliarse mediante el siguiente enlace del Laboratorio Multimedia de la Universidad Pablo de Olavide: https://upotv.upo.es/series/58da216a238583e0478b48f0

El programa también presenta debilidades. La muestra fue escasa y sólo participaron hombres. Aunque científicamente válidas y fiables, se utilizaron pruebas de campo para la valoración de la capacidad funcional. Futuros estudios deberían utilizar muestras mayores e incluir mujeres y métodos de evaluación de la capacidad funcional más precisos para poder abordar la temática en mayor profundidad.

5. LECCIONES APRENDIDAS

Un programa de ejercicio físico combinado (ejercicio de tipo aeróbico y de fuerza) de 12 semanas tuvo efectos positivos sobre aspectos directamente relacionados con la calidad de vida y salud del grupo experimental de presos psiquiátricos, mostrando una reducción clínicamente importante en la presencia de factores de riesgo cardiovascular y riesgo de muerte prematura, así como un aumento de la capacidad funcional. En definitiva, el ejercicio físico puede ser un tratamiento preventivo alternativo, sencillo y económico, como demostró el presente trabajo.

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Tabla 1. Cambios entre grupos en las variables de estudios.

Variables	Grupo (n)	Media Pre (SD)	Media Post (SD)	Cambio (%)	TE ± LC 90%	Cualitativo
Medidas antropométricas						
Índice Masa Corporal. kg/m^2	GE (26)	28.0 (3.7)	27.7 (3.8)	-0.9	0.07 ± 0.46	Improbable, 32/52/16
	GC (26)	29.9 (3.5)	29.5 (3.71)	-1.3		
Grasa corporal. %	GE (25)	25.5(6.6)	24.7 (7.1)	-3.8	0.31 ± 0.48	Posible, 65/31/4
	GC (22)	29.8 (6.9)	30.2 (6.7)	1.4		
Masa muscular. kg	GE (25)	34.8 (4.0)	34.9 (3.3)	0.5	0.57 ± 0.48	Posible, 90/10/1
	GC (22)	34.9 (4.9)	34.2 (4.8)	-2.0		
Perímetro cintura. cm	GE (25)	95.3 (7.6)	92.2 (9.0)	-3.4	0.28 ± 0.46	Posible, 62/34/4
	GC (26)	100.9 (9.2)	99.4 (10.3)	-1.6		
Perímetro cadera. cm	GE (25)	101.1 (7.2)	101.7 (7.4)	0.5	0.03 ± 0.46	Improbable, 26/53/21
	GC (26)	102.2 (7.7)	102.8 (7.7)	0.6		
Índice cintura-cadera	GE (25)	0.94 (0.05)	0.91 (0.06)	-3.9	0.29 ± 0.46	Posible, 63/33/4
	GC (26)	0.99 (0.07)	0.97 (0.06)	-2.3		
Índice cadera-altura	GE (25)	0.55 (0.05)	0.53 (0.06)	-3.4	0.23 ± 0.46	Improbable, 55/39/6
	GC (26)	0.59 (0.06)	0.58 (0.06)	-1.9		
Índice ABSI	GE (25)	0.79 (0.04)	0.77 (0.05)	-2.8	0.54 ± 0.46	Probable, 89/11/0
	GC (26)	0.80 (0.04)	0.80 (0.04)	-0.8		
Capacidad funcional						
Dinamometría manual. kg	GE (26)	46.0 (8.3)	48.7 (9.2)	5.5	0.24 ± 0.46	Improbable, 56/38/6
	GC (26)	46.0 (7.5)	47.6 (7.8)	3.5		
Arm curl test. n° repeticiones	GE (26)	31.1 (6.6)	35.6 (7.2)	14.7	0.93 ± 0.46	Muy probable, 99/1/0
	GC (26)	28.4 (4.9)	28.7 (4.3)	1.6		
Chair stand test. n° repeticiones	GE (24)	27.7 (5.5)	31.0 (5.4)	12.1	0.81 ± 0.47	Muy probable, 98/2/0
	GC (26)	27.1 (5.6)	27.1 (5.6)	0.2		
Test 6 minutos. m	GE (26)	634.3 (67.0)	683.5 (138.1)	6.4	0.62 ± 0.46	Probable, 94/6/0
	GC (26)	590.9 (65.7)	587.6 (73.4)	-0.7		
Muestras sanguíneas						
Glucosa. mg/dL	GE (21)	83.3 (6.6)	82.8 (7.9)	-0.7	0.16 ± 0.51	Improbable, 45/43/12
	GC (22)	89.7 (12.7)	88.1 (12.6)	-1.7		
Colesterol. mg/dL	GE (21)	171.5 (46.5)	169.7 (36.7)	0.5	0.29 ± 0.51	Improbable, 61/33/6
	GC (21)	185.6 (45.6)	195.1 (44.9)	5.7		
Triglicéridos. mg/dL	GE (21)	165.3 (140.8)	115.8 (59.0)	-22.1	0.29 ± 0.51	Improbable, 62/32/5
	GC (22)	172.4 (120.9)	159.7 (100.7)	-5.4		

Abreviaturas: n: casos; Pre: antes del periodo de intervención; Post: después del periodo de intervención; Dif: diferencia; TE: tamaño del efecto de Cohen; LC: límites de confianza; GE: grupo experimental; GC: grupo control.

Los valores para considerar el TE fueron: trivial (0,0 – 0,19), pequeño (0,2 – 0,59), moderado (0,6 – 1.1), largo (1,2 – 1,9) y muy largo (>2,0). Las probabilidades cuantitativas de diferencia positiva/trivial/negativa se evaluaron cualitativamente de la siguiente manera: <25% improbable, 25 a 75% posible,> 75% probable,> 95% muy probable y >99% casi con certeza. Se consideró un cambio sustancial cuando la posibilidad de positivo/trivial/negativo fue >75%.

Tabla 2. Presencia de factores de riesgo cardiovascular antes y después de la intervención.

Variables	Grupo	n/N Pre	n/N Post	Dif ABS. (n)	Dif REL (%)
Índice Masa Corporal ≥ 25 Kg/m2	GE	21/26	19/26	-2	-7.7
	GC	26/26	26/26	0	0.0
Porcentaje grasa ≥ 25 %	GE	15/25	13/25	-2	-8.0
	GC	15/21	17/21	2	+9.5
Perímetro de cintura ≥ 102 cm	GE	8/25	5/25	-3	-12.0
	GC	11/26	9/26	-2	-7.7
Índice Cintura-Cadera ≥ 0.9	GE	19/25	11/25	-8	-32.0
	GC	24/26	23/26	-1	-3.8
Índice Cadera-Altura ≥ 0.5	GE	20/25	18/25	-2	-8.0
	GC	26/26	25/26	-1	-3.8
Glucosa ≥ 126 mg/dL	GE	0/21	0/21	0	0.0
	GC	0/22	1/22	1	+4.5
Colesterol ≥ 200 mg/dL	GE	6/21	3/21	-3	-14.3
	GC	7/21	8/21	1	+4.8
Triglicéridos ≥ 150 mg/dL	GE	9/21	4/21	-5	-23.8
	GC	10/22	10/22	0	0.0
Total	GE	98/189	73/198	-25	-13.2
	GC	119/119	119/199	0	0.0

NOTA: Para cada variable solo aparecen los sujetos con registro antes y después de periodo de intervención.

Abreviaturas: n: muestra subgrupo que presenta un factor de riesgo; N: muestra total grupo; Pre: antes del periodo de intervención; Post: después del periodo de intervención; Dif ABS: diferencia absoluta; Dif REL: diferencia relativa; GE: grupo experimental; GE: grupo control.

CONCLUSIONES

1. En personas con esquizofrenia, un alto índice de masa corporal, una baja condición cardiorrespiratoria y peor puntación en el componente sumario físico se asociaron con un comportamiento más sedentario y el índice de masa corporal. La condición cardiorrespiratoria y la vitalidad fueron identificados factores determinantes del comportamiento sedentario.
2. Las personas con trastorno mental severo tuvieron una baja prevalencia de indicadores de salud cardiovascular ideal, especialmente la dieta y el índice de masa corporal. Bajos niveles de comportamiento sedentario, y altos niveles de condición cardiorrespiratoria y fuerza muscular se asociaron con un mayor puntaje de salud cardiovascular global, y solo la condición cardiorrespiratoria permaneció significativamente relacionada independientemente del comportamiento sedentario y la fuerza muscular.
3. En personas con psicosis, altos niveles de comportamiento sedentario y bajos niveles de actividad física y condición cardiorrespiratoria se asociaron con un mayor riesgo cardiometabólico agrupado, y solo la condición cardiorrespiratoria permaneció significativamente relacionada independientemente de los múltiples factores de confusión (incluyendo el comportamiento sedentario y la actividad física). Además, la condición cardiorrespiratoria y el comportamiento sedentario se asociaron con la circunferencia de la cintura y el comportamiento sedentario con los niveles de glucosa en sangre, siendo todas estas asociaciones independientes de las otras variables de interés.
4. Las personas con trastorno mental severo experimentaron el 58% del tiempo despierto en comportamientos sedentarios, principalmente viendo la televisión. El método auto-reportado presentó una baja validez en comparación con el método objetivo, siendo más alto en los días entresemana para el grupo general y para los grupos de jóvenes, alta duración de la enfermedad y bajo nivel de medicación antipsicótica.
5. Las personas con trastorno mental grave deberían cumplir con la recomendación de 150 minutos de actividad física a la semana, reducir el tiempo en actividades sedentarias y tener niveles adecuados de condición física. Los cuestionarios International Physical Activity Questionnaire – short form, Sedentary Behaviour Questionnaire y el Test de caminar 6 minutos son herramientas sencillas y de

bajo coste adecuadas para evaluar actividad física, comportamiento sedentario y condición física en esta población.

6. Cambios en el estilo de vida durante 18 meses, principalmente aumentando el nivel de actividad física y comer más saludablemente, mejoraron la salud cardiovascular y condición física y redujeron el comportamiento sedentario, peso corporal, síntomas psiquiátricos y el uso de medicación en una mujer con trastorno bipolar.
7. Una intervención grupal de 12 semanas de entrenamiento supervisado de ejercicio aeróbico y de fuerza fue segura, factible y efectiva para mejorar la condición cardiorrespiratoria, fuerza muscular y parámetros antropométricos en presos psiquiátricos.
8. Una intervención grupal de 12 semanas de entrenamiento supervisado de ejercicio aeróbico y de fuerza redujo la presencia de factores de riesgo cardiovascular en presos psiquiátricos.

CONCLUSIONS

1. In people with schizophrenia, a higher body mass index, a lower cardiorespiratory fitness and worse physical component score were associated with a more sedentary behaviour. Body mass index, cardiorespiratory fitness and vitality were identified as determinants of sedentary behavior.
2. People with severe mental illness had a low prevalence of ideal cardiovascular health metrics, especially diet and body mass index. Low sedentary behaviour, high cardiorespiratory fitness, high muscular strength levels were associated with higher global cardiovascular health score, and only cardiorespiratory fitness remained significantly related independent of sedentary behaviour and muscular strength.
3. In people with psychosis, high levels of sedentary behaviour and low levels of physical activity and cardiorespiratory fitness were associated with a higher clustered-cardiometabolic risk, and only cardiorespiratory fitness remained significantly related independent of multiple confounders (including sedentary behaviour and physical activity). Cardiorespiratory fitness and sedentary behaviour were associated with waist circumference and sedentary behaviour with fasting blood glucose, and all of these associations were independent of the other potential exposures.
4. People with severe mental illness spent 58% of waking time sedentary, primarily watching television. The self-reported method presented low validity compared to the objective method, being higher on weekdays for the overall group and for the younger, high illness duration and low antipsychotic medication groups.
5. People with severe mental illness should meet the recommended 150 minutes of physical activity per week, reduce time in sedentary activities and have adequate fitness levels. The International Physical Activity Questionnaire – short form, Sedentary Behavior Questionnaire and the 6-minute walk test are simple and low-cost tools suitable for evaluating physical activity, sedentary behavior and fitness in this population.
6. A 18-month lifestyle changes, primarily increasing time engaged in physical activity and eating healthier, improved cardiovascular health and fitness, and reduced sedentary behaviour, body weight, severity of psychiatric symptoms and mediation use in a woman with bipolar disorder.

7. A 12-week group-based intervention of supervised aerobic and strength exercise training was safe, feasible, and effective for improving cardiorespiratory fitness, muscular strength, and anthropometric parameters in psychiatric men inmates.
8. A 12-week group-based intervention of supervised aerobic and strength exercise training was safe, feasible, reduced the presence of cardiovascular risk factors in psychiatric men inmates.

CURRICULUM VITAE ABREVIADO [SHORT CV]

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Actividad académica

- Licenciado en Ciencias de la Actividad Física y del Deporte. Universidad Pablo de Olavide. 2007-2012.
- Master oficial en Rendimiento Físico y Deportivo Universidad Pablo de Olavide. 2012-2013.
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- Estancia de investigación en University of New South Wales, Sydney, Australia. De 12/11/2017 a 12/12/2017.

Participación en proyectos de investigación

Referencia: UZ2016-BIO-03.
Título del proyecto: “Influencia del tipo y volumen de entrenamiento sobre la salud y de la práctica de deporte en edades tempranas”.
Entidad financiadora: Universidad de Zaragoza.
Duración, desde: 01/01/2016 hasta: 31/12/2016.
Cuantía de la subvención: 2.000 €.
Investigador responsable: Dr. Alejandro Legaz Arrese. Universidad de Zaragoza.
Tipo de participación: Investigador.

Referencia: HC15586.

Título del proyecto: “Validation of the Simple Physical Activity Questionnaire (SIMPAQ)”.

Entidad financiadora: University of New South Wales, Sydney (Australia).

Duración, desde: 01/01/2016 hasta: actualidad.

Cuantía de la subvención: 0 €.

Investigadores responsables: Simon Rosenbaum y Philip Ward (University of New South Wales, Australia; Schizophrenia Research Unit, South Western Sydney Local Health District).

Tipo de participación: Investigador.

Referencia: 2017/RM08.

Título del proyecto: “Influencia del estilo de vida y condición física cardiorrespiratoria sobre el riesgo cardiometabólico y efectos del ejercicio en el tratamiento del trastorno mental grave”.

Entidad financiadora: Catedra Real Madrid-Universidad Europea de Madrid.

Duración, desde: 01-10-2017 hasta: 30-09-2018.

Cuantía de la subvención: 5.348 €.

Investigador responsable: Dr. Diego Munguía Izquierdo. Universidad Pablo de Olavide.

Tipo de participación: Investigador.

Referencia: DEP2017-86406-R.

Título del proyecto: “Estilo de vida, ejercicio físico y salud en pacientes con trastorno mental grave”.

Entidad financiadora: Universidad Pablo de Olavide. Ayudas Puente para el Plan Estatal de I+D.

Duración, desde: 12-06-2018 hasta: 12-06-2019.

Cuantía de la subvención: 7.000 €.

Investigador responsable: Diego Munguía Izquierdo. Universidad Pablo de Olavide.

Tipo de participación: Investigador.

Participación en proyectos de innovación docente

Proyectos de Innovación y Desarrollo Docente Universidad Pablo de Olavide. Acción 2 curso 2016-2017: Proyectos destinados al diseño y aplicación de nuevas metodologías docentes y evaluadoras, prioritariamente enfocadas a la formación en competencias. Título: “Clases on -line como refu
Fundamento del Deporte III (bloque de natación)”. Coordinador: Alfonso Murillo Fuentes. Tipo de participación: Investigador.

Proyectos de Innovación y Desarrollo Docente Universidad Pablo de Olavide. Acción 3 curso 2016-2017: Diseño y aplicación de materiales docentes con soporte digital. Título: “Creación de material multimedia para la valoración de la capacidad física funcional de personas inactivas”. Coordinador: Diego Munguía Izquierdo. Tipo de participación: Investigador.

Proyectos de Innovación y Desarrollo Docente Universidad Pablo de Olavide. Acción 2 curso 2017-2018: Proyectos destinados al diseño y aplicación de nuevas metodologías docentes y evaluadoras, prioritariamente enfocadas a la formación en competencias. Título: “Desarrollo y aplicación de un entorno digital para el control y evaluación en las enseñanzas de las asignaturas de Planificación y Evaluación de la Educación Física y de Actividad Física y Salud en el Grado de Ciencias de la Actividad física y del deporte”. Coordinador: Federico Paris García. Tipo de participación: Investigador.

Proyectos de Innovación y Desarrollo Docente Universidad Pablo de Olavide. Acción 3 curso 2017-2018: Diseño y aplicación de materiales docentes con soporte digital. Título: “Diseño y aplicación de material multimedia para la valoración de la condición cardiorrespiratoria mediante una prueba de caminata incremental”. Coordinador: Diego Munguía Izquierdo. Tipo de participación: Investigador.

Publicaciones científicas

<u>En revistas contempladas en Journal Citation Reports (JCR)</u>

1. **Bueno-Antequera J**, Oviedo-Caro MÁ, Munguía-Izquierdo D. Sedentary behaviour patterns in outpatients with severe mental illness: a cross-sectional study using objective and self-reported methods. The PsychiActive project. Psychiatry Res. 2017; 255:146-152. Factor de impacto de la revista (2017): 2.223 (61/142) 2º Cuartil. Psychiatry.

2. Oviedo-Caro MA, **Bueno-Antequera J,** Munguía-Izquierdo D. Spanish version of Pregnancy Symptoms Inventory: transcultural adaptation and reliability. J Matern Fetal Neonatal Med. 2017; 30(18):2185-2192. Factor de impacto de la revista (2017): 1.493 (62/82) 4º Cuartil. Obstetrics and Gynecology.
3. **Bueno-Antequera J**, Oviedo-Caro MÁ, Munguía-Izquierdo D. Relationship between objectively measured sedentary behavior and health outcomes in schizophrenia patients: The PsychiActive project. Schizophr Res. 2018; 197:87-92. Factor de impacto de la revista (2017): 3.958 (33/142) 1º Cuartil. Psychiatry.
4. Munguia-Izquierdo D, Mayolas-Pi C, Peñarrubia-Lozano C, Paris-Garcia F, **Bueno-Antequera J**, Oviedo-Caro MA, Legaz-Arrese A. Effects of Adolescent Sport Practice on Health Outcomes of Adult Amateur Endurance Cyclists: Adulthood Is Not Too Late to Start. J Phys Act Health. 2017, 1;14(11):876-882. Factor de impacto de la revista (2017): 1.723 (71/156) 2º Cuartil. Public environmental and occupational health.
5. Mayolas-Pi C, Munguia-Izquierdo D, Peñarrubia-Lozano C, Reverter-Masia J, **Bueno-Antequera J**, López-Laval I, Oviedo-Caro MÁ, Murillo-Lorente V, Murillo-Fuentes A, Paris-García F, Legaz-Arrese A. Adherence to the Mediterranean diet in inactive adults, indoor cycling practitioners and amateur cyclists. Nutr Hosp. 2017, 24;35(1):131-139. Factor de impacto de la revista (2016): 0.747 (68/81) 4º Cuartil. Nutrition and dietetics.
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Aportaciones a congresos científicos

(Únicamente se muestran los relacionados con la presente Tesis)

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