



# UNIVERSIDAD DE MURCIA

ESCUELA INTERNACIONAL DE DOCTORADO

Nivel e Influencia de la Actividad Física  
en Jóvenes y Adultos Españoles  
con Enfermedades Pulmonares Crónicas

**D.<sup>a</sup> Sheila Sánchez Castillo**

2021



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## ESCUELA INTERNACIONAL DE DOCTORADO

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Adultos Españoles con Enfermedades Pulmonares  
Crónicas

Tesis Doctoral Internacional para optar al grado de Doctor Internacional por:

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San Javier, enero 2022



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**AUTHORISE:**

The presentation of the Doctoral Thesis entitled: **“LEVEL AND IMPACT OF PHYSICAL ACTIVITY IN SPANISH YOUTH AND ADULTS WITH CHRONIC PULMONARY DISEASES”**, conducted by Ms. Sheila Sánchez Castillo, under my immediate management and supervision, presented to obtain the Doctoral Degree by the University of Murcia.

Cambridge, September 1<sup>st</sup>, 2021

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Cambridge, September 1<sup>st</sup>, 2021

Mr. Lee Smith

A handwritten signature in blue ink, appearing to be 'Lee Smith', is positioned below the printed name.



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En Murcia, a 1 de septiembre de 2021.

Dº Arturo Díaz Suárez

*“Un camino de mil millas comienza con un paso”*

*Benjamin Franklin*

# ***AGRADECIMIENTOS***

Durante este largo periodo de trabajo para la elaboración de esta tesis, son muchas las personas que de uno u otro modo han estado presentes y han hecho que este documento que a continuación se presenta haya sido posible, por ello me gustaría agradecer a todas ellas:

A Guillermo Felipe López Sánchez, por ser la primera persona en confiar en mí para sumergirme en este bonito y duro camino, por dirigir de la mejor manera posible este proyecto, por su ayuda incondicional y su trabajo y apoyo constante. Sin él muy probablemente nunca habría dado el paso para llevar a cabo la tesis doctoral.

A Arturo Díaz Suárez por su gran trabajo como tutor y director, por haber estado siempre que lo he necesitado.

A Lee Smith por ofrecerme su ayuda constantemente sin necesidad de pedirla, y por abrirme las puertas de su despacho para darle un carácter internacional a esta tesis mediante una estancia en Anglia Ruskin University (Cambridge). Sin duda fue una experiencia inolvidable y enriquecedora para el desarrollo de esta tesis y para mí personalmente.

A la Fundación Séneca, por la confianza depositada en este proyecto y por financiarlo. Agradecer especialmente a Viviane Barelli su trato y amabilidad inigualable, y su disposición y ayuda cuando la he necesitado.

A mis compañeros y amigos de CAFD, que siempre me apoyaron en esta “locura” y confiaron en mí, antes que yo misma.



A mi padre, que sé que estaría muy orgulloso de mi por llegar hasta donde he llegado. Siempre lo estuvo y siempre lo estará.

Por último, me gustaría agradecer a mi madre y mis hermanos por su apoyo incondicional en todas mis decisiones, por valorarme más de lo que yo misma lo hago, por su cariño y confianza. Me habéis enseñado a no rendirme, a confiar más en mí y creer que puedo llegar a conseguir lo que me proponga.

Y a toda mi familia por creer en mí.

Millones de gracias a todos.

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## TESIS DOCTORAL COMO COMPENDIO DE PUBLICACIONES

Esta tesis doctoral se presenta como un compendio de seis artículos publicados en revistas científicas de impacto indizadas en el Journal Citation Report (1 Q1, 3 Q2, 1 Q3, 1 Q4):

- Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A. & López-Sánchez, G.F. (2019). Physical Activity Behaviour in People with COPD Residing in Spain: A Cross-Sectional Analysis. *Lung*, 197(6), 769-775. <https://doi.org/10.1007/s00408-019-00287-4> . PMID: 31686208.
- Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A. & López-Sánchez, G.F. (2020). Associations between Physical Activity and Comorbidities in People with COPD Residing in Spain: A Cross-Sectional Analysis. *International Journal of Environmental Research and Public Health*, 17(2), 594. <https://doi.org/10.3390/ijerph17020594>
- Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A. & López-Sánchez, G.F. (2020). Levels of physical activity in Spanish asthmatics: A cross-sectional study. *Medicina*, 56(12), 643. <https://doi.org/10.3390/medicina56120643>
- Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A. & López-Sánchez, G.F. (2020). Analysis of physical activity and comorbidities in Spanish asthmatics. *Sustainability*, 12 (13), 5256. <https://doi.org/10.3390/su12135256>
- Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A. & López-Sánchez, G.F. (2021). Physical activity behavior in people with asthma and COPD overlap residing in Spain: A cross-sectional analysis. *Journal of asthma*. <https://doi.org/10.1080/02770903.2021.1888977>
- Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A. & López-Sánchez, G.F. (2021). Association between Physical Activity and Comorbidities in Spanish People with Asthma-COPD Overlap. *Sustainability*, 13(14), 7580. <https://doi.org/10.3390/su13147580>

Para mantener una apariencia homogénea en el documento, los seis artículos se presentan en un mismo formato. En el apartado de anexos se incluye la primera página de cada uno de los trabajos tal y como fueron publicados.

## RESUMEN

**Introducción:** La enfermedad pulmonar obstructiva crónica (EPOC) y el asma son dos de las cinco enfermedades respiratorias más significativas. Ambas enfermedades son consideradas como importantes problemas de salud pública debido, no solo a su elevada prevalencia, sino también a su carga socioeconómica y elevada morbimortalidad. En 2019, la herramienta de resultados de Carga Global de Enfermedad (Global Burden of Disease–GBD-), mostró una prevalencia mundial de asma del 3,5% y del 2,8% en EPOC. Además, el 5,8% de las muertes en el mundo se debieron a la EPOC. Asimismo, existen pacientes que muestran características de ambas enfermedades, lo que se conoce como solapamiento de asma y EPOC (ACO). Algunos estudios recientes han sugerido que la actividad física (AF) podría tener un efecto protector en pacientes con EPOC y asma, pues se asocia a una mejor calidad de vida y menor morbimortalidad.

**Objetivos:** Analizar los niveles de AF y estudiar las relaciones entre estos niveles de AF y la presencia de comorbilidades en jóvenes y adultos españoles con enfermedades pulmonares crónicas como EPOC, asma y ACO.

**Métodos:** Esta tesis doctoral se compone de seis artículos con un diseño transversal. En todos ellos, se analizaron los datos de la Encuesta Nacional de Salud 2017, en la que participaron un total de 23.089 personas residentes en España con al menos 15 años, de las cuales 17.777 respondieron al Cuestionario Internacional de AF versión corta (IPAQ-SF). Aquellos adultos mayores de 69 años fueron excluidos, porque no completaron el IPAQ-SF, pues éste fue desarrollado y testado en personas de entre 15 y 69 años. Según el estudio, se incluyeron como participantes aquellos que respondieron positivamente a la pregunta: “¿Alguna vez ha sido diagnosticado por un médico con EPOC y/o asma?” A nivel de análisis estadístico, se emplean estadísticos descriptivos para definir la muestra, para detallar la cantidad de AF semanal (MET·min/semana) y el nivel de AF (bajo/moderado/alto), y para determinar la prevalencia de las diferentes comorbilidades. Para establecer las diferencias significativas en la cantidad semanal de AF se utilizan los test U Mann-Whitney y H Kruskal-Wallis, mientras que en el nivel de AF se calcula mediante el estadístico chi-cuadrado. La asociación entre el nivel de AF y las comorbilidades se analiza mediante tres modelos distintos de regresión logística multinomial: 1) sin ajustar; 2) ajustado por sexo, índice de masa corporal (IMC), edad,

estado civil, nivel educativo, tabaco y alcohol; 3) ajustado por las mismas variables que el modelo dos, el consumo de medicamentos y la presencia de comorbilidades.

**Resultados y conclusiones:** El 37,8% de españoles con EPOC muestran un nivel bajo de AF, predominando un volumen inferior en mujeres, en mayores de 60 años, en abstemios y en aquellos con obesidad o bajo peso. En asmáticos, el porcentaje de españoles con nivel bajo de AF es ligeramente inferior (31,6%), encontrándose los niveles significativamente más reducidos en mujeres, en aquellos mayores de 30, en aquellos con bajo nivel educativo, en aquellos casados y/o viviendo en pareja, en abstemios y en obesos. En aquellos con ACO, el 35,9% presentan un nivel bajo de AF, estando estos niveles significativamente más reducidos en mayores de 60 años y en obesos. Aunque en valores promedios los españoles con EPOC, asma y ACO muestren un nivel de AF moderado, más del 30% no alcanzan las recomendaciones. Además, un nivel bajo de AF se asocia con un mayor riesgo de comorbilidades, concretamente de incontinencia urinaria, estreñimiento crónico, dolor lumbar crónico, cataratas, ansiedad crónica y osteoporosis. Por ello, se recomienda implementar programas para concienciar sobre la importancia y los beneficios de la AF en personas con EPOC y/o asma, focalizándose en aquellos grupos con niveles más reducidos.

## [SUMMARY]

**Introduction:** Chronic Obstructive Pulmonary Disease (COPD) and asthma are two of the major five respiratory diseases. Both conditions are important public health problems not only because their increasing prevalence, but also because their socioeconomic burden and high morbimortality. In 2019, the Global Burden of Disease (GBD) showed a worldwide prevalence of asthma and COPD of 3.5% and 2.8%, respectively. Moreover, COPD was accountable for 5.8% of global deaths. Additionally, some patients have clinical feature of both asthma and COPD, which is known as Asthma-COPD Overlap (ACO). Several studies suggested PA could have a protective effect among patients with COPD and asthma, since it is related with a better quality of life and lower morbimortality.

**Objectives:** To analyse PA levels and to study the associations between those PA levels and the presence of comorbidities in Spanish youth and adults with chronic pulmonary diseases like COPD, asthma and ACO.

**Methods:** This doctoral thesis is composed of six observational papers with a cross-sectional design. Data from the Spanish National Health Survey 2017 were analysed in all papers. A total of 23 089 people residing in Spain and aged 15 years and over participated in the survey, of which 17 777 answered the International Physical Activity Questionnaire Short Form (IPAQ-SF). Those aged over 69 years were excluded, since they did not complete IPAQ-SF, because it was developed and tested in people aged from 15 to 69 years. Depending on the paper, those who answered positively to the following question: Have you ever been diagnosed with COPD/asthma/both by a physician? were included in the analyses. Considering the statistical analysis, descriptive statistics were used to define the sample, to establish weekly amount of PA (MET·min/week) and PA level (low/moderate/high), and to determine the prevalence of the different comorbidities. To establish significant differences in weekly amount of PA, Mann-Whitney U test and Kruskal-Wallis H test were used. In case of PA level, chi-squared test were employed to determine the significant differences. Associations between PA level and comorbidities were analysed using the multivariable logistic regression analyses in three different models: 1) not adjusted; 2) adjusted for sex, body mass index (BMI), age, marital status, education level, smoking and alcohol consumption; 3) adjusted for the same variables as model 2 adding the variables medication intake and presence of comorbidities.

**Results and conclusions:** 37.8% of Spanish with COPD showed a low level of PA. Weekly volume was lower in women, those older than 60 years, those abstemious, and those obese or underweight. Considering asthmatics, the percentage of Spanish with low PA level was slightly lower (31.6%). PA levels were significantly reduced in women, those older than 30 years, those with low education level, those married and/or living together, those abstemious and those with obesity. Meanwhile, 35.9% of those with ACO showed a low level of PA, being significantly reduced in those older than 60 years and those with obesity. Although, on average, Spanish with COPD, asthma and ACO showed a moderate PA level, more than 30% did not achieve PA recommendations. Moreover, a low level of PA is related with a higher risk of comorbidities, specifically urinary incontinence, chronic constipation, chronic lumbar pain, cataracts, chronic anxiety and osteoporosis. Therefore, it is recommended to implement programs that promote the importance and benefits of PA among those with COPD and/or asthma, focusing in those groups with reduced PA levels.

# ***INTRODUCCIÓN***



La enfermedad pulmonar obstructiva crónica (EPOC) y el asma son dos de las cinco enfermedades respiratorias más importantes según el Foro de Sociedades Respiratorias Internacionales (FISR, 2017). Ambas enfermedades son consideradas importantes problemas de salud pública debido a su elevada prevalencia, a su alta morbimortalidad y a su carga socioeconómica (Global Initiative for Asthma [GINA], 2020 & Global Initiative for Chronic Obstructive Lung Disease [GOLD], 2020). En 2019, la herramienta de carga global de enfermedad mostró una prevalencia mundial de asma y EPOC de 3.5% y 2.8%, respectivamente (Institute for Health, Metrics and Evaluation [IHME], 2019). Además, la EPOC fue la tercera causa de muerte en 2019, siendo responsable de aproximadamente el 5,8% del total de fallecimientos (IHME, 2019; World Health Organization [WHO], 2020)

A nivel nacional, el estudio EPI-SCAN (EPIde miologic Study of COPD in SpAiN) mostró una prevalencia de EPOC del 10,2% en adultos de entre 40 y 80 años (Miravittles et al., 2009). Anteriormente, el estudio IBERPOC (Estudio Epidemiológico de la EPOC en España) determinó una prevalencia de EPOC del 9,1% en adultos de 40 a 69 años (Sobradillo et al., 1999). Sin embargo, siguiendo los datos de la Encuesta Nacional de Salud 2017, se encontró una prevalencia de EPOC en españoles de entre 15 y 69 años del 3,2% con distribución similar entre sexos (3,3% hombres vs 3,2% mujeres), mientras que la prevalencia de asma era ligeramente superior con un 4,6%, siendo mayor en mujeres (5.6%) (Ministerio de Sanidad, Consumo y Bienestar Social, 2018).

Ambas enfermedades se caracterizan por una limitación del flujo aéreo y la presencia de síntomas respiratorios, pero existen ciertas diferencias entre ellas que se deben tener en cuenta. La EPOC se describe como una limitación persistente del flujo aéreo espiratorio, con una proporción entre el volumen espiratorio forzado en el primer segundo ( $VEF_1$ ) y la capacidad vital forzada (CVF) inferior a 0,70 tras el uso del broncodilatador (GOLD, 2020). En asmáticos, la limitación del flujo aéreo y los síntomas como sibilancias, tos, dificultad respiratoria y presión en el pecho varían en intensidad y mejoran con el uso de broncodilatadores o incluso espontáneamente (GINA, 2020). El asma se suele diagnosticar antes de los 40 años mientras que la EPOC suele ocurrir a partir de los 40 y generalmente en aquellos que han estado expuestos al humo del tabaco u otras partículas nocivas (GINA, 2020). No obstante, encontramos algunos pacientes que presentan características clínicas de ambas enfermedades. Estudios previos utilizaban el término síndrome de solapamiento de asma y EPOC (ACOS) para referirse a estos

pacientes (Alshabat et al., 2015; Tommola et al., 2017), pero las últimas actualizaciones de las guías GOLD (2020) y GINA (2020) utilizan el término solapamiento asma-EPOC (ACO) o asma+EPOC para referirse a estos fenotipos clínicos, pues no se trata de una enfermedad propia, sino de la combinación de ambas enfermedades.

Los costes sanitarios derivados de estas enfermedades no pasan inadvertidos. En España, la EPOC origina aproximadamente el 10% de consultas de atención primaria, el 40% de consultas externas de neumología y el 7% de hospitalizaciones anuales (Álvarez-Sala et al., 2001). Asimismo, una parte importante del coste del asma se asocia a admisiones de urgencia, hospitalizaciones y mortalidad (Barnes et al., 1996). La falta de control del asma supone costes elevados (Doz et al., 2013), que podrían reducirse mejorando el control de la misma.

En pacientes con ACO, a pesar de su dificultad de diagnóstico, especialmente en fumadores y adultos mayores, la literatura previa sugiere que éstos tienen mayor probabilidad de presentar síntomas respiratorios (Menezes et al., 2014; Miravittles et al., 2013), peor función pulmonar (Menezes et al., 2014), mayor uso de los recursos sanitarios y hospitalizaciones (Andersen et al., 2013; Hardin et al., 2014; Menezes et al., 2014), calidad de vida pobre (Alshabanat et al., 2015; Kauppi, 2011), exacerbaciones frecuentes (Alshabanat et al., 2015) y una mayor mortalidad (Kendzierska et al., 2011), en comparación con aquellos que presentan solo EPOC o asma.

### **Actividad física y enfermedades pulmonares crónicas**

La realización de AF de manera regular y mantenida ayuda en la prevención, tanto primaria como secundaria, de varias enfermedades crónicas (Haskell et al., 2007; Marques et al., 2018; Warburton et al., 2006). A pesar de ello, investigaciones previas encontraron limitada la práctica de AF en personas con EPOC (Troosters et al., 2013), incluso en etapas tempranas (Van Helvoort et al., 2016; Van Remoortel et al., 2016), lo que se relaciona con un mayor riesgo de hospitalización y readmisión (García-Aymerich et al., 2006) e incluso la muerte (García-Río et al., 2012; Waschki et al., 2011). De manera similar, en asmáticos, los síntomas del asma junto con el miedo de aparición de broncoconstricción inducida por el ejercicio (BIE), podrían tener un impacto negativo sobre sus niveles de AF (Cordova-Rivera et al., 2018).

Sin embargo, la literatura sugiere que la práctica regular de AF en personas con EPOC se asocia con una mejor calidad de vida (Cebollero et al., 2018; García-Aymerich

et al., 2003; García-Aymerich et al., 2009) y una menor morbilidad (Benzo et al., 2010; Waschki et al., 2011). Un estudio de cohorte prospectivo llevado a cabo en Barcelona mostró que aquellos que caminaban al menos una hora al día tenían menor riesgo de hospitalización por exacerbación (García-Aymerich et al., 2003). Recientemente, otro estudio prospectivo que analizó la eficacia clínica de un programa de caminata en personas con EPOC encontró mejoras tanto en la calidad de vida como en el número de exacerbaciones (Cebollero et al., 2018).

Igualmente, la práctica regular de AF también favorece el control del asma (Côté et al., 2018; Freitas et al., 2019), reduciendo consecuentemente el riesgo de crisis asmática (GINA, 2020). Diferentes investigaciones sugieren que la realización de AF de manera regular reduce los síntomas del asma (Loponen et al., 2018; Turner et al., 2011), la sensibilidad de las vías aéreas (França-Pinto et al., 2015), la EIB (Côté et al., 2018) y el riesgo de exacerbaciones asmáticas (França-Pinto et al., 2015). También se ha demostrado que la AF mejora la capacidad física (Carson et al., 2013; Eichenberger et al., 2013) y la calidad de vida (Côté et al., 2018; França-Pinto et al., 2015) en personas asmáticas. Respecto a la función pulmonar, existen diferentes puntos de vista sobre los beneficios de la AF. Carson et al. (2013) no encontraron un impacto significativo de la AF sobre la capacidad pulmonar. Por el contrario, Eichenberger et al. (2013) encontraron mejoras en el VEF<sub>1</sub> en aquellos asmáticos que realizaban entrenamiento físico. Además, una revisión sistemática determinó que aquellos que realizaban más AF tendrían menor riesgo de desarrollar asma, lo que contribuiría también a reducir los costes sanitarios derivados de la enfermedad (França-Pinto et al., 2015).

Por su parte, en aquellos con solapamiento de asma y EPOC, la literatura sobre los niveles de AF es escasa, pero una investigación reciente en adultos españoles (40-80 años) reveló niveles inferiores de AF en comparación con aquellos que sólo tenían EPOC. Sin embargo, la muestra estaba formada únicamente por 67 adultos con ACO, por lo que la representatividad de los resultados es limitada (Miravittles et al., 2013).

### **Comorbilidades y nivel de actividad física**

La EPOC y el asma son enfermedades heterogéneas que pueden asociarse con otras comorbilidades. El término comorbilidad fue acuñado por Feinstein en 1970 como “cualquier enfermedad adicional coexistente”.

En asmáticos, las comorbilidades pueden ser independientes o estar asociadas a la enfermedad, pero, en cualquier caso, éstas pueden complicar el manejo clínico del asma (Boulet, 2009; Ledford & Lockey, 2013), aumentar el riesgo de exacerbación (Zhang et al., 2009), suponer atención asmática no programada (Steppuhn, Langen, Keil & Scheidt-Nave, 2014), un vago control del asma y deterioro de la calidad de vida (GOLD, 2020) e incluso aumentar la mortalidad (To et al., 2014). Las comorbilidades más comunes en pacientes con asma son la rinosinusitis, las alergias alimentarias, el síndrome de apnea obstructiva del sueño (SAOS), el reflujo gastroesofágico (ERGE) y los problemas de salud mental (Boulet, 2009; Ceylan et al., 2019; GOLD, 2020; Ledford & Lockey, 2013). Además, un estudio reciente mostró también una prevalencia elevada en adultos asmáticos escoceses de hipertensión, depresión, dolor muscular y EPOC (Weatherburn et al., 2017). La literatura existente muestra que los asmáticos presentan significativamente más comorbilidades que los no asmáticos (Gershon et al., 2012; Su et al., 2016). Asimismo, aquellos pacientes obesos muestran mayores dificultades en el control del asma, probablemente debido a un tipo diferente de inflamación de las vías respiratorias, que contribuye a desarrollar otras comorbilidades como SAOS y ERGE, así como por un bajo estado de forma y reducido volumen pulmonar causado por la grasa abdominal, lo que favorece la disnea (GOLD, 2020).

La presencia de comorbilidades en aquellos con EPOC es bastante alta. Un estudio reciente encontró que el 80% de los pacientes con EPOC presentaban al menos una comorbilidad, aunque generalmente coexisten múltiples comorbilidades (Sieve et al., 2015). Previamente Barr et al. (2009) establecieron una media de nueve comorbilidades en personas con EPOC. Las comorbilidades con mayor prevalencia en pacientes con EPOC son de tipo cardiovascular, metabólicas, musculoesqueléticas y psicológicas (Franssen & Rochester, 2014). Éstas pueden estar presentes en pacientes en cualquier estadio y conlleva una mayor tasa de hospitalización (Mannino et al., 2008) y aumento de la mortalidad (Barnes & Celli, 2009). Además, se encontró que el nivel de AF puede verse deteriorado por la presencia de comorbilidades, con independencia del grado de limitación del flujo aéreo y el tipo de comorbilidad (Miller et al., 2013; Sievi et al., 2015).

Predeciblemente, la presencia de comorbilidades también es bastante común en pacientes con ACO (Barrecheguren et al., 2020; Krishnan et al., 2019; Rubio et al., 2017; van Boven et al., 2016). Investigaciones previas mostraron que la diabetes, la enfermedad cardiovascular, la hipertensión, la dispepsia, la arritmia, la úlcera gástrica, la ansiedad y

la depresión eran las comorbilidades más frecuentes en pacientes con ACO. (Barrecheguren et al., 2020; Krishnan et al., 2019; Rubio et al., 2017).

No hay evidencia sobre cómo los niveles de AF pueden contribuir a reducir el riesgo de comorbilidades en asmáticos y pacientes con ACO, y en pacientes con EPOC es bastante escasa.

***[INTRODUCTION]***

Chronic obstructive pulmonary disease (COPD) and asthma are two of the five major respiratory diseases, established by the Forum of International Respiratory Societies (FIRS, 2017). Both conditions are important public health problems owing to their increasing prevalence, high morbimortality and socioeconomic burden (GINA, 2020 & GOLD, 2020). In 2019, the Global Burden of Disease tool showed a worldwide prevalence of asthma and COPD of 3.5% and 2.8%, respectively (IHME, 2019). Moreover, COPD was the third leading cause of death, responsible for approximately a 5.8% of total deaths in 2019 (IHME, 2019; WHO, 2020).

Considering national data, the EPI-SCAN study (Epidemiologic Study of COPD in Spain), revealed a national prevalence of COPD of 10.2% in adults aged from 40 to 80 years (Miravittles et al., 2009). Previously, the IBERPOC (Epidemiological study of COPD in Spain) found a COPD prevalence of 9,1% in people aged from 40 to 69 years (Sobradillo et al., 1999). However, according to data from the Spanish National Health Survey 2017, the prevalence of COPD in Spanish people aged 15 to 69 years was found to be 3.2%, with a similar distribution between sexes (3.3% men vs 3.2% women), while the prevalence of asthma was slightly higher, with a 4.6%, being greater in women (5.6%) (Ministerio de Sanidad, Consumo y Bienestar Social, 2018).

These respiratory conditions are characterized by airflow limitation and respiratory symptoms, but there are some differences between them that need to be considered. COPD is defined by persistent expiratory airflow limitation, with a ratio between forced expiratory volume in the first second ( $FEV_1$ ) and forced vital capacity (FVC) lower than 0.70 post-bronchodilator use (GOLD, 2020). In asthmatics, expiratory airflow limitation and symptoms such as wheeze, cough, shortness of breath and chest tightness vary over time in intensity and improve with the use of bronchodilators or even spontaneously (GINA, 2020). Onset of asthma tends to be before the age of 40 years while COPD tends to occur after 40 years and generally in those who have been exposed to tobacco or any other noxious particles (GINA, 2020). However, some patients have clinical features of both asthma and COPD. Previous studies have used the term Asthma-COPD overlap syndrome (ACOS) to describe these patients (Alshabat et al., 2015; Tammola et al., 2017), but latest updates of GOLD (2020) and GINA (2020) have named these clinical phenotypes Asthma-COPD overlap (ACO) or asthma+COPD, since it is not a definition of a single condition but a combination of both asthma and COPD.

Healthcare costs caused by these diseases have not gone unnoticed. Importantly, a total of 10% of primary care consultations, 40% of pneumology consultations and 7% of annual hospitalizations in Spain are due to COPD (Álvarez-Sala et al., 2001). Moreover, an important part of the cost of asthma is associated to urgent admissions, hospitalization and mortality (Barnes et al., 1996). Thus, uncontrolled asthma has significantly high costs (Doz et al., 2013), which could be reduced by improving disease control.

In turn, despite the difficulty of diagnosing ACO patients, especially in smokers and older adults, previous literature suggests that patients with ACO are more likely to have respiratory symptoms (Menezes et al., 2014; Miravittles et al., 2013), worse lung function (Menezes et al., 2014), higher rates of use of health care resources and hospitalizations (Andersen et al., 2013; Hardin et al., 2014; Menezes et al., 2014), poor quality of life (Alshabanat et al., 2015; Kauppi, 2011), experience frequent exacerbations (Alshabanat et al., 2015) and have a higher rate of mortality (Kendzierska et al., 2011), compared with their pairs with asthma or COPD alone.

### **Physical activity and chronic respiratory diseases**

Regular and sustained participation in PA aids in both primary and secondary prevention of several chronic diseases (Haskell et al., 2007; Marques et al., 2018; Warburton et al., 2006). However, previous investigations revealed a limitation of PA in people with COPD (Troosters et al., 2013), even in early stages (Van Helvoort et al., 2016; Van Remoortel et al., 2016), which is related with a high risk of hospitalization and readmission (García-Aymerich et al., 2006) and even death (García-Río et al., 2012; Waschki et al., 2011). Similarly, in asthmatics, asthma symptoms together with the fear of having exercise-induced bronchoconstriction (EIB), could have a negative impact on PA levels (Cordova-Rivera et al., 2018).

Even though, previous literature suggests that regular participation in PA is associated with better quality of life (Cebollero et al., 2018; García-Aymerich et al., 2003; García-Aymerich et al., 2009) and fewer morbidities in people with COPD (Benzo et al., 2010; Waschki et al., 2011). A prospective cohort study carried out in Barcelona revealed that those who walked for at least one hour per day had a lower risk of hospitalization by a COPD exacerbation (García-Aymerich et al., 2003). Recently, another prospective study that analysed the clinic efficacy of a walking program in people with COPD showed improvements in both quality of life and exacerbation's number (Cebollero et al., 2018).



In the same way, regular PA aids in the control of asthma (Côté et al., 2018; Freitas et al., 2019) which consequently reduces the risk of asthma crisis (GINA, 2020). Different investigations suggest that a usual amount of PA reduces the symptoms of asthma (Loponen et al., 2018; Turner et al., 2011), airway responsiveness (França-Pinto et al., 2015), EIB (Côté et al., 2018) and the risk of asthma exacerbations (França-Pinto et al., 2015). It has also been demonstrated that PA improves exercise capacity (Carson et al., 2013; Eichenberger et al., 2013) and quality of life (Côté et al., 2018; França-Pinto et al., 2015) in people suffering from asthma. Regarding lung function, there is no agreement about the benefits of PA. Carson et al. (2013) found that PA had no significant impact on lung function, but Eichenberger et al. (2013) found improvements in FEV<sub>1</sub> in asthmatics who engaged in exercise training. Moreover, a systematic review proposed that people involved in more PA may have less risk of developing asthma, which will also contribute to reduce health cost (França-Pinto et al., 2015).

In those with ACO, literature about PA level is scarce but a recent investigation in Spanish adults (aged 40-80 years) revealed lower levels of PA in comparison to those with only COPD. However, only 67 adults with ACO participated in the study and thus the representation of the findings is limited (Miravittles et al., 2013).

### **Comorbidities and physical activity level**

Both asthma and COPD are heterogeneous diseases that can be associated with several comorbidities. The term comorbidity was coined by Feinstein in 1970 and it refers to “any additional co-existing ailment”.

In asthmatics, comorbidities could be independent or associated with the disease, but they could complicate the clinical management of asthma (Boulet, 2009; Ledford & Lockey, 2013), increasing the risk for exacerbation (Zhang et al., 2009), unscheduled asthma care (Steppuhn et al., 2014), poor asthma control and impaired of life quality (GOLD, 2020) and mortality (To et al., 2014). The most frequent conditions are rhinosinusitis, food allergy, obstructive sleep apnoea syndrome (OSAS), gastroesophageal reflux (GER) and mental health disorders (Boulet, 2009; Ceylan et al., 2019; GOLD, 2020; Ledford & Lockey, 2013). Moreover, a recent study showed a high prevalence of hypertension, depression, pain and COPD among Scottish adults with asthma (Weatherburn et al., 2017). Previous literature found that asthmatics have significantly more comorbid conditions than non-asthmatics (Gershon et al., 2012; Su et

al., 2016). Besides, obese patients show more difficulties in the control of asthma, probably because of a different type of airway inflammation that contributes to other comorbidities like OSAS and GER and due to a poor shape and a decrease in lung volume caused by abdominal fat, which contributes to dyspnoea (GOLD, 2020).

The presence of comorbidities among patients with COPD is pretty high. It was found that 80% of COPD patients had at least one comorbidity (Sieve et al., 2015), but generally multiple comorbidities coexist. Previously, Barr et al. (2009) found an average of nine comorbidities in people with COPD. The most prevalent comorbidities among patients with COPD are cardiovascular, metabolic, musculoskeletal and psychological diseases (Franssen & Rochester, 2014). Comorbidities can occur in patients with any degree of COPD and they could drive to a high hospitalization rate (Mannino et al., 2008) and increased mortality (Barnes & Celli, 2009). Furthermore, PA level was found to be impaired by the presence of comorbidities independent of the degree of airflow limitation and the type of comorbidity (Miller et al., 2013; Sievi et al., 2015).

Unsurprisingly, the presence of comorbidities is very common among patients with ACO too (Barrecheuren et al., 2020; Krishnan et al., 2019; Rubio et al., 2017; Van Boven et al., 2016). The most frequent comorbid conditions found among ACO patients in previous investigations were diabetes, cardiovascular disease, hypertension, eczema, rhinitis, musculoskeletal diseases, dyspepsia, arrhythmia, gastric ulcers, anxiety and depression (Barrecheuren et al., 2020; Krishnan et al., 2019; Rubio et al., 2017).

To author's knowledge, there is no evidence about how PA levels can contribute to reduce the risk of comorbidities in asthmatics nor in ACO adults, and literature among COPD is very scarce.

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# ***OBJETIVOS***

### **Objetivo general**

El objetivo general de esta tesis doctoral es analizar los niveles de actividad física y estudiar la relación de éstos con la presencia de diferentes comorbilidades en jóvenes y adultos con EPOC, asma o ACO. residentes en España

### **Objetivos específicos**

- I. Determinar la cantidad de AF física semanal que practican jóvenes y adultos españoles con EPOC, asma y ACO, analizando las diferencias según sexo, edad, nivel educativo, estado civil, convivencia en pareja, hábito tabáquico, consumo de alcohol e índice de masa corporal. (Artículos I, III y V)
- II. Analizar los niveles de AF (bajo, moderado, alto) de jóvenes y adultos españoles con EPOC, asma y ACO según sexo, edad, nivel educativo, estado civil, convivencia en pareja, hábito tabáquico, consumo de alcohol e índice de masa corporal. (Artículos I, III y V)
- III. Determinar la prevalencia de 31 comorbilidades diferentes en jóvenes y adultos españoles con EPOC, asma y ACO (Artículos II, IV y VI)
- IV. Evaluar la influencia del nivel de AF sobre la presencia de comorbilidades en jóvenes y adultos españoles con EPOC, asma y ACO (Artículos II, IV y VI)

**[AIMS]**

**General aim**

The general aim of this doctoral thesis is to analyze physical activity levels and to evaluate their influence on the presence of different comorbidities among youth and adults with COPD, asthma or ACO residing in Spain.

**Specific aims**

- I. To determine the weekly amount of PA in which Spanish youth and adults with COPD, asthma and ACO are engaged, considering the differences by sex, age, education level, marital status, living together, smoking habits, alcohol consumption and BMI. (Papers I, III and V)
- II. To analyze PA levels (low, moderate, high) among Spanish youth and adults with COPD, asthma and ACO according to sex, age, education level, marital status, living together, smoking habits, alcohol consumption and BMI. (Papers I, III and V)
- III. To determine the prevalence of 31 different comorbidities among Spanish youth and adults with COPD, asthma and ACO. (Papers II, IV and VI).
- IV. To evaluate the influence of PA levels on the presence of comorbidities among Spanish youth and adults with COPD, asthma and ACO (Papers II, IV and VI).

# MÉTODOS



La presente tesis doctoral se basa en los datos obtenidos de seis artículos de tipo descriptivo y observacional con un diseño transversal, que se han llevado a cabo siguiendo la lista de verificación STROBE (Strengthening the Reporting of Observational Studies in Epidemiology). En todos ellos, se analizaron los datos del cuestionario de adultos de la Encuesta Nacional de Salud 2017, en la que participaron un total de 23.089 personas residentes en España, de las cuales 17.777 respondieron al cuestionario de AF. Aquellos adultos mayores de 69 años fueron excluidos, pues no completaron el Cuestionario Internacional de Actividad Física versión corta (IPAQ-SF), dado que éste ha sido desarrollado y testado en personas de entre 15 y 69 años. El IPAQ ha sido validado en poblaciones adultas de diferentes países mostrando una validez ( $\rho = 0.30$ , 95% CI: 0.23–0.36) y fiabilidad aceptables ( $\rho = 0.81$ , 95% CI: 0.79–0.82) (Craig et al., 2003). En función del estudio, se incluyeron como participantes aquellos que respondieron positivamente a la pregunta: “¿Alguna vez ha sido diagnosticado por un médico con EPOC y/o asma?”

Los métodos seguidos aparecen detallados en cada uno de los artículos. No obstante, a continuación, se recoge en formato tabla la información metodológica de manera resumida para cada uno de los estudios (Tabla 1):

- I. Patrones de actividad física en personas con EPOC residentes en España: Un análisis transversal.
- II. Relación entre actividad física y comorbilidades en personas con EPOC residentes en España: un análisis transversal.
- III. Nivel de actividad física en asmáticos españoles: Un estudio transversal.
- IV. Análisis de actividad física y comorbilidades en asmáticos españoles.
- V. Patrones de actividad física en personas con solapamiento asma-EPOC residentes en España: un análisis transversal.
- VI. Relación entre actividad física y comorbilidades en españoles con solapamiento asma-EPOC.

**Tabla 1.** Resumen de la metodología de los diferentes artículos.

<b>Diseño</b>	<b>Artículos</b>	<b>Participantes</b>	<b>VARIABLES</b>	<b>Análisis Estadístico</b>
Transversal	I. Patrones de AF en personas con EPOC residentes en España.	615: ♀327 ♂288 Edad: 15-69	AF Sexo, edad, educación, estado civil, convivencia, tabaco, alcohol, IMC	Descriptivos U Mann-Whitney H Kruskal-Wallis Chi-cuadrado
	III. Nivel de AF en asmáticos españoles.	1014: ♀587 ♂427 Edad: 15-69		
Observacional	V. Patrones de AF en personas con ACO residentes en España.	198: ♀120 ♂78 Edad: 15-69		
	II. Relación entre AF y comorbilidades en personas con EPOC residentes en España.	601: ♀314 ♂287 Edad: 15-69	AF (Exposición) Comorbidityes (Resultado)	Descriptivos Chi-cuadrado
Relacional	IV. Análisis de AF y comorbilidades en asmáticos españoles.	1014: ♀587 ♂427 Edad: 15-69	Sexo, edad, educación, estado civil, tabaco, alcohol, IMC, medicación, presencia de comorbilidades	T-student Regresión logística multivariable
	VI. Relación entre AF y comorbilidades en españoles con ACO.	198: ♀120 ♂78 Edad: 15-69		

*AF: Actividad Física; EPOC: Enfermedad Pulmonar Obstructiva Crónica; ACO: Solapamiento asma-EPOC; IMC: Índice de Masa Corporal*

# **[METHODS]**

This doctoral thesis is based on data obtained from six descriptive and observational papers with a cross-sectional design. All papers have been carried out following the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist. Data from the Spanish National Health Survey 2017 were analysed. A total of 23 089 people residing in Spain and aged 15 years and over participated in the survey, of which 17 777 answered the PA questionnaire. Those aged over 69 years were excluded, since they did not complete the International Physical Activity Questionnaire short form (IPAQ-SF). IPAQ has been validated in adult populations from different countries showing an acceptable validity ( $\rho = 0.30$ , 95% CI: 0.23–0.36) and reliability ( $\rho = 0.81$ , 95% CI: 0.79–0.82) (Craig et al., 2003). Depending on the paper, those who answered positively to the following question: Have you ever been diagnosed with COPD/asthma/both by a physician? were included in the analyses.

Methods are detailed in each paper. However, the methodological information of each paper is summarized on the following table (Table 1):

- I. Physical Activity Behaviour in People with COPD Residing in Spain: A Cross-Sectional Analysis.
- II. Associations between Physical Activity and Comorbidities in People with COPD Residing in Spain: A Cross-Sectional Analysis.
- III. Levels of Physical Activity in Spanish Asthmatics: A Cross-Sectional Study.
- IV. Analysis of Physical Activity and Comorbidities in Spanish Asthmatics.
- V. Physical activity behavior in people with asthma and COPD overlap residing in Spain: a cross-sectional analysis
- VI. Association between Physical Activity and Comorbidities in Spanish People with Asthma-COPD Overlap.

**Table 1.** Summary of the methods of the different articles.

<b>Design</b>	<b>Papers</b>	<b>Participants</b>	<b>Variables</b>	<b>Statistical Analysis</b>
Cross-sectional Descriptive Observational Relational	I. PA Behaviour in People with COPD Residing in Spain	615: ♀327 ♂288 Age: 15-69	PA Sex, age, education, marital status, cohabiting, smoking, alcohol, BMI	Descriptives Mann-Whitney U Kruskal-Wallis H Chi-squared
	III. Levels of PA in Spanish Asthmatics.	1014: ♀587 ♂427 Age: 15-69		
	V. Physical activity behavior in people with ACO residing in Spain.	198: ♀120 ♂78 Age: 15-69		
	II. Associations between PA and Comorbidities in People with COPD Residing in Spain.	601: ♀314 ♂287 Age: 15-69	PA (Exposure) Comorbidities (Outcomes) Sex, age, education, marital status, smoking, alcohol, BMI, medication, presence of comorbidities	Descriptives Chi-squared Student-T Multivariable logistic regression
	IV. Analysis of PA and Comorbidities in Spanish Asthmatics.	1014: ♀587 ♂427 Age: 15-69		
	VI. Association between PA and Comorbidities in Spanish People with ACO.	198: ♀120 ♂78 Age: 15-69		

PA: Physical Activity; COPD: Chronic Obstructive Pulmonary Disease; ACO: Asthma-COPD Overlap; BMI: Body Mass Index

**ARTÍCULOS PUBLICADOS**  
**[PUBLISHED PAPERS]**

**ENFERMEDAD PULMONAR OBSTRUCTIVA  
CRÓNICA  
[COPD]**

**Artículos I y II  
[Papers I and II]**

# **ARTÍCULO I [PAPER I]**

## **Physical Activity Behaviour in People with COPD Residing in Spain: A Cross-Sectional Analysis**

Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A., López-Sánchez, G.F.

Received: 18 July 2019 / Accepted: 19 October 2019 /

Published online: 4 November 2019

Journal: Lung



## Physical Activity Behaviour in People with COPD Residing in Spain: A Cross-Sectional Analysis

**Revista:** Lung

**Abstract:**

**Purpose** Chronic obstructive pulmonary disease (COPD) represents a major public health problem due to its high prevalence, morbidity and health cost. It has been demonstrated that physical activity (PA) is one of the most beneficial measures to prevent chronic diseases. The aim of this study was to examine PA levels of adults with COPD residing in Spain, and to analyse the differences by sex, age, education, marital status, cohabiting, tobacco consumption, alcohol consumption and body mass index.

**Methods** A total of 615 adults aged 15 to 69 years participated in this study. Data from the Spanish National Health Survey 2017 were used. This survey included the short version of IPAQ to measure PA levels. PA was expressed in total volume (MET·min/week), classified as low, moderate and high, and analysed according to sample characteristics. Statistical significance was set at  $p < 0.05$  (CI = 95%).

**Results** Level of PA was higher in men than in women (1808.8 vs. 1575.6 MET·min/week;  $p = 0.016$ ), in those aged under 30 years than in those older than 60 years (2129.4 vs. 1381.4 MET·min/week;  $p = 0.047$ ) and in those who drank alcohol than in those who did not drink (1912.8 vs. 1248.2 MET·min/week;  $p = 0.004$ ). Also, underweight and obese participants participated in lower levels of PA than normal weight participants ( $p = 0.001$ ). When classifying PA level, a total of 37.9% had a low level, 47.5% had a moderate level and only 14.6% had a high level of PA ( $p < 0.001$ ).

**Conclusion** It is recommendable to implement programs to raise awareness of the importance and benefits of PA in the control of COPD, and these programs should focus on those with lower levels of PA.

**URL:** <https://doi.org/10.1007/s00408-019-00287-4>

# **ARTÍCULO II [PAPER II]**

## **Associations between Physical Activity and Comorbidities in People with COPD Residing in Spain: A Cross-Sectional Analysis**

Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A., López-Sánchez, G.F.

Received: 23 December 2019 / Accepted: 15 January 2020 /

Published: 16 January 2020

Journal: International Journal of Environmental Research and Public Health

## **Associations between Physical Activity and Comorbidities in People with COPD Residing in Spain: A Cross-Sectional Analysis**

**Revista:** International Journal of Environmental Research and Public Health

**Abstract:**

There is a high prevalence of comorbidities among patients with chronic obstructive pulmonary disease (COPD). Comorbidities are likely common in patients with any COPD degree and are associated with increased mortality. The aim of this study was to determine the prevalence of thirty-one different COPD comorbidities and to evaluate the association between physical activity (PA) levels in people with COPD residing in Spain. Cross-sectional data from the Spanish National Health Survey 2017 were analysed. A total of 601 adults (52.2% females) with COPD aged 15 to 69 participated in this study. PA (exposure) was measured with the International Physical Activity Questionnaire (IPAQ) short form and comorbidities (outcomes) were self-reported in response to the question “Have you ever been diagnosed with ...?” Multivariable logistic regression, in three different models, was used to assess this association. Results showed a high prevalence of comorbidities (94%), these being chronic lumbar back pain (38.9%), chronic allergy (34.8%), arthrosis (34.1%), chronic cervical back pain (33.3%), asthma (32.9%) and hypertension (32.8%) the most prevalent. Low PA level was significantly associated with urinary incontinence (2.115[1.213–3.689]), chronic constipation (1.970[1.119–3.459]), cataracts (1.840[1.074–3.153]), chronic anxiety (1.508[1.002–2.269]) and chronic lumbar back pain (1.489[1.044–2.125]). Therefore, people with COPD should increase their PA levels in order to reduce their risk of comorbidities and increase their quality of life.

**URL:** <https://doi.org/10.3390/ijerph17020594>

**ASMA [ASTHMA]**

**Artículos III y IV**  
**[Papers III and IV]**

# **ARTÍCULO III [PAPER III]**

## **Levels of Physical Activity in Spanish Asthmatics: A Cross- Sectional Study**

Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A., López-Sánchez, G.F.

Received: 27 October 2020 / Accepted: 23 November 2020 /

Published: 25 November 2020

Journal: Medicina

## Levels of Physical Activity in Spanish Asthmatics: A Cross-Sectional Study

**Revista:** Medicina

**Abstract:**

**Background and objectives:** 339 million people in the world suffer from asthma. Regular physical activity (PA) could help in its control. Therefore, the aim of this research was to determine the level of PA in Spanish people with asthma considering variation by age, sex, education, marital status, living together, smoking habits, alcohol intake and body mass index (BMI).

**Materials and Methods:** 1014 Spanish people from 15 to 69 years were included in the study. Data of the Spanish Health Survey (year 2017) were analysed. PA levels were measure with the international physical activity questionnaire short version (IPAQ-SF). PA was categorized as low, moderate and high, and analyzed by sample characteristics. Mann-Whitney U test, Kruskal Wallis H and crosstabs were used to calculate statistical significance ( $p < 0.05$ ).

**Results:** On average, Spanish asthmatics engaged in a weekly volume of 2228.9 metabolic equivalent of task (MET)·min/week. Males revealed significantly higher PA than females (2516.8 vs 2019.5 MET·min/week;  $p = 0.005$ ), younger participants (<30 years) compared to people aged 30–60 years and older than 60 years (2699.0; 2243.2; 1619.3 MET·min/week;  $p < 0.001$ ) and those with tertiary level of education than those without secondary (2368.3 vs. 2168.3 MET·min/week;  $p = 0.001$ ). Level of PA was lower in those married ( $p = 0.001$ ) and/or living together ( $p = 0.010$ ). Alcohol consumers showed a higher level than the participants who did not drink (2378.3 vs. 1907.9 MET·min/week;  $p = 0.001$ ), but no significant differences were found within current, past and never smokers ( $p = 0.890$ ). Obese asthmatics engaged in less PA than their normal weight and overweight peers ( $p < 0.001$ ). Overall, moderate level was significantly the most frequent (47.7%), but 31.6% showed a low level.

**Conclusions:** Three out of ten Spanish people with asthma do not achieve PA recommendations, so PA programs should be executed to make people aware of its benefits in asthma control, focusing on those groups with lower PA levels.

**URL:** <https://doi.org/10.3390/medicina56120643>

# **ARTÍCULO IV [PAPER IV]**

## **Analysis of Physical Activity and Comorbidities in Spanish Asthmatics**

Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A., López-Sánchez, G.F.

Received: 21 May 2020 / Accepted: 26 June 2020 /

Published: 29 June 2020

Journal: Sustainability

## **Analysis of Physical Activity and Comorbidities in Spanish Asthmatics**

**Revista:** Sustainability

**Abstract:**

The prevalence of comorbidities in asthmatics is high. Comorbidities may complicate the clinical management of asthma, increasing the risk for exacerbation and even death. The objective of the present research was to establish the prevalence of 31 asthma comorbidities and to assess the association of these comorbidities with physical activity (PA) in Spanish asthmatics. Data of the Spanish National Health Survey 2017 (cross-sectional design) were used in this study. A total of 1014 people (42.1% males) with asthma participated in this study (age range 15–69 years). The IPAQ (International Physical Activity Questionnaire) short form was the instrument administered to evaluate PA (exposure), and the self-reported answer to the question “Have you ever been diagnosed with...?” determined the presence of comorbidities (outcomes). This association was assessed by multivariable logistic regression. Results demonstrated a huge presence of comorbidities (89.3%). The most prevalent were chronic allergy (61.1%), chronic lumbar pain (28.7%), chronic cervical pain (24.2%), high cholesterol (20.9%), Chronic Obstructive Pulmonary Disease (COPD) (19.4%), migraine (19.2%) and hypertension (19.3%). PA level under 600 metabolic equivalent of task (MET)·min/week showed a significant association with urinary incontinence (3.10 [1.62–5.94]), osteoporosis (1.90 [1.00–3.61]) and chronic anxiety (1.69 [1.13–2.53]). Therefore, comorbidities and PA levels should be considered in the prevention and treatment of asthmatics, in order to improve their quality of life.

**URL:** <https://doi.org/10.3390/su12135256>



# **SOLAPAMIENTO ASMA-EPOC**

**[ACO]**

**Artículos V y VI**

**[Papers V and VI]**

# **ARTÍCULO V [PAPER V]**

## **Physical activity behavior in people with asthma and COPD overlap residing in Spain: a cross- sectional analysis**

Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A., López-Sánchez, G.F.

Received: 22 October 2020 / Accepted: 2 February 2021 /

Published online: 01 March 2021

Journal: Journal of asthma

## **Physical activity behavior in people with asthma and COPD overlap residing in Spain: a cross-sectional analysis**

**Revista:** Journal of asthma

**Abstract:**

**Objectives:** To identify levels of physical activity (PA) among the Spanish population with asthma and chronic obstructive pulmonary disease overlap (ACO). A further aim was to analyze differences in PA levels by sex, age, education, marital status, cohabiting, smoking habits, alcohol consumption and body mass index (BMI).

**Methods:** In this cross sectional study, data from the Spanish National Health Survey 2017 were analyzed. A total of 198 people with ACO aged 15–69 years were included in the analyses. The short version of the international physical activity questionnaire (IPAQ) was used to measure total PA (MET·min/week). PA was further classified as low, moderate and high, and analyzed according to sample characteristics. Data were analyzed using the Mann-Whitney U test, Kruskal-Wallis H test and chi squared test. Statistical significance was set at  $p < 0.05$ .

**Results:** People with ACO engaged in a mean volume of 2038.1 MET·min/week. Those aged 30–60 years and those with normal weight were significantly more active than those aged  $\geq 60$  and those with obesity. When classifying PA level in low, moderate and high, results showed no significant differences between sample characteristics. Overall, moderate and high levels of PA were the most and least frequent levels (48.0% and 16.2%, respectively).

**Conclusions:** More than three out of ten Spanish adults with ACO do not achieve PA recommendations. Therefore, it is recommended to implement programs that promote the importance and benefits of PA among the Spanish population with ACO, and such programs should focus on older adults and those who are obese.

**URL:** <https://doi.org/10.1080/02770903.2021.1888977>

# **ARTÍCULO VI [PAPER VI]**

## **Association between Physical Activity and Comorbidities in Spanish People with Asthma-COPD Overlap**

Sánchez-Castillo, S., Smith, L., Díaz-Suárez, A., López-Sánchez, G.F.

Received: 7 June 2021 / Accepted: 2 July 2021 /

Published: 7 July 2021

Journal: Sustainability

## Association between Physical Activity and Comorbidities in Spanish People with Asthma-COPD Overlap

**Revista:** Sustainability

**Abstract:**

Asthma and chronic obstructive pulmonary disease (COPD) are important conditions which often coexist. Higher rates of comorbidities among people with asthma-COPD overlap (ACO) may complicate clinical management. The aim of this study was to determine the prevalence of 30 different comorbidities and to analyze associations between these comorbidities and physical activity (PA) in Spanish people with ACO. Cross-sectional data from the Spanish National Health Survey 2017 were analyzed. A total of 198 Spanish people with ACO aged 15–69 years (60.6% women) were included in this study. PA was measured with the International Physical Activity Questionnaire (IPAQ) short form. Diagnosis of chronic conditions were self-reported. Associations between PA and comorbidities were analyzed using multivariable logistic regression models. The most prevalent comorbidities were chronic allergy (58.1%), chronic lumbar pain (42.4%), chronic cervical pain (38.4%), hypertension (33.3%) and arthrosis (31.8%). A PA level lower than 600 MET·min/week was significantly associated with urinary incontinence (OR = 3.499, 95% CI = 1.369–8.944) and osteoporosis (OR = 3.056, 95% CI = 1.094–8.538) in the final adjusted model. Therefore, the potential influence of PA on reducing the risk of these conditions among people with ACO should be considered, not only because of the health benefits, but also because PA can contribute to a more sustainable world.

**URL:** <https://doi.org/10.3390/su13147580>

# **CONCLUSIONES**

A continuación, se presentan las conclusiones generales de la tesis doctoral, en relación a los objetivos planteados en cada uno de los artículos que la componen:

- En españoles con EPOC y en asmáticos, la cantidad semanal de actividad física varía en función del sexo, la edad, el consumo de alcohol y el IMC. Entre aquellos que presentan EPOC, la cantidad de AF era menor en mujeres, en aquellos mayores de 60 años, en los que consumen alcohol y en aquellos con obesidad o bajo peso. Entre los asmáticos, la cantidad de AF era significativamente inferior en mujeres, en mayores de 30 años, en aquellos que consumen alcohol y en aquellos con obesidad. Además, en asmáticos también se encontraron diferencias en el nivel educativo, siendo menor la práctica de AF en aquellos con bajo nivel educativo, y en el estado civil y la convivencia en pareja, siendo la cantidad semanal de AF inferior en casados y/o viviendo en pareja. (Artículos I y III).
- Entre los españoles con ACO, la cantidad semanal de AF es inferior en mayores de 60 y en obesos. (Artículo V).
- En valores medios, los españoles con EPOC, asma o ACO muestran un nivel de AF moderado. No obstante, existe un elevado porcentaje que no alcanza los niveles mínimos recomendados. Aproximadamente tres de cada diez españoles entre 15 y 69 años con estas enfermedades presentan un nivel bajo de AF. El mayor porcentaje de pacientes con nivel bajo de AF es el de personas con EPOC (37.9%), seguido de aquellos con ACO (35.8%) y finalmente se encuentran los asmáticos (31.6%).
- Se recomienda implementar programas para concienciar a la población sobre la importancia y los beneficios de la AF en el control de las enfermedades pulmonares crónicas estudiadas en esta tesis. Además, estos programas deben incluir actividades que motiven a los participantes a mantener la práctica de AF a largo plazo y deben focalizarse en aquellos grupos que muestran niveles de AF más reducidos. Así, se podría mejorar la calidad de vida de estos pacientes (Artículos I, III y V).
- La presencia de comorbilidades en jóvenes y adultos españoles con enfermedades pulmonares crónicas es muy elevada. Aproximadamente nueve de cada diez pacientes con EPOC y/o asma presentan comorbilidades. Entre los que padecen EPOC, las comorbilidades con mayor prevalencia son dolor lumbar crónico, alergia crónica, artrosis, dolor cervical crónico, asma e hipertensión. En

asmáticos, la comorbilidad con mayor prevalencia es la alergia crónica, seguida del dolor lumbar y cervical, colesterol elevado, EPOC, migrañas e hipertensión. Por su parte, aquellos con solapamiento de ambas muestran una mayor prevalencia también en alergia crónica, seguida de dolor lumbar y cervical e hipertensión (Artículos II, IV y VI).

- Un nivel bajo de AF se asocia con un mayor riesgo de incontinencia urinaria, estreñimiento, cataratas, ansiedad crónica y dolor lumbar crónico en pacientes con EPOC; incontinencia urinaria, osteoporosis y ansiedad crónica en asmáticos; e incontinencia urinaria y osteoporosis en aquellos con ACO, con los modelos ajustados según sexo, edad, nivel educativo, estado civil, consumo de tabaco y alcohol, obesidad, presencia de comorbilidades y consumo de medicamentos. Por tanto, se sugiere que la realización de la cantidad de AF recomendada podría reducir el riesgo de comorbilidades en pacientes con EPOC, asma y ACO.
- La presencia de comorbilidades, especialmente de incontinencia urinaria, estreñimiento, dolor lumbar, cataratas, ansiedad crónica y osteoporosis, y los niveles de AF deberían tenerse en cuenta tanto en la prevención como en el tratamiento de pacientes con EPOC, asma y ACO, con la intención de mejorar su calidad de vida.



**[CONCLUSIONS]**

The general conclusions of this doctoral thesis are presented in relation to the aims brought up in the six papers that compose it:

- In Spanish people with COPD and in asthmatics, weekly amount of PA varies according to sex, age, alcohol consumption and BMI. In those with COPD, PA was significantly lower in women, those older than 60 years, those who drank alcohol and in those with obesity or underweight. In asthmatics, PA was significantly lower in women, those older than 30 years, those who drank alcohol and in those with obesity. Moreover, asthmatics revealed significant differences according to education level, marital status and living in couple. Those with low education level and those married and/or living together presented a lower weekly amount of PA (Papers I and III).
- In Spanish people with ACO, weekly amount of PA was significantly lower in those older than 60 years and in those with obesity. (Paper V).
- On average, Spanish people with COPD, asthma or ACO revealed a moderate level of PA. Even though, there is a high percentage of people that do not achieve PA recommendations. Around three out of ten Spanish people aged from 15 to 69 years showed a low level of PA. The highest percentage of people with a low level of PA was found among those with COPD (37.9%), followed by those with ACO (35.8%) and finally asthmatics (31.6%) (Papers I, III and V).
- It is recommendable to implement programs to raise awareness of the importance and benefits of PA in the control of the chronic pulmonary diseases. These programs should include activities that motivate participants to do long-term PA and should focus on those groups with lower PA. This way, they could improve their quality of life (Paper I, III, and V).
- The presence of comorbidities among Spanish youth and adults with chronic pulmonary diseases is very high. Nine out of ten COPD and/or asthmatic patients present comorbidities. In people with COPD, the most prevalent comorbidities are chronic lumbar pain, chronic allergy, arthrosis, chronic cervical pain, asthma and hypertension. In asthmatics the most prevalent one is chronic allergy, followed by chronic lumbar and cervical pain, high cholesterol, COPD, migraine and hypertension. In those with ACO, the most prevalent comorbidity is also chronic allergy, followed by chronic lumbar and cervical pain and hypertension. (Paper II, IV and VI)

- A low level of PA is associated with a higher risk of urinary incontinence, chronic constipation, cataracts, chronic anxiety and chronic lumbar pain among those with COPD; urinary incontinence, osteoporosis and chronic anxiety among those with asthma; and urinary incontinence and osteoporosis among those with ACO. Models were adjusted for sex, age, education level, marital status, smoking, alcohol consumption, obesity, presence of comorbidities and medication intake. Thus, it is suggested that achieving PA recommendations could reduce the risk of comorbidities in patients with COPD, asthma and ACO.
- Comorbidities, especially urinary incontinence, chronic constipation, lumbar pain, cataracts, chronic anxiety and osteoporosis, and PA levels should be considered in the prevention and treatment of people with COPD, asthma and ACO, in an attempt to improve their quality of life.

**FUTURAS**  
**INVESTIGACIONES**

En futuras investigaciones se debería llevar a cabo una revisión sistemática y meta-análisis de la literatura existente sobre la práctica de AF y su influencia en personas con enfermedades pulmonares crónicas (EPOC, asma y ACO) de todo el mundo. Con ello se pretende sintetizar la evidencia disponible en esta temática, para incrementar la validez de las conclusiones de los estudios que componen esta tesis e identificar áreas de incertidumbre donde sea necesario seguir investigando. También sería conveniente corroborar los resultados obtenidos con otros estudios en los que se valore la AF de manera directa mediante acelerómetros previamente validados.

Asimismo, se considera necesario realizar en un futuro investigaciones de seguimiento longitudinal en las que se apliquen diferentes programas de AF en personas con las enfermedades pulmonares crónicas abordadas en esta tesis y con niveles bajos de AF que permitan observar su evolución y determinar qué tipo de programas son más efectivos. Por ejemplo, se podría plantear un seguimiento de un programa de AF mediante marcha nórdica y otro basado en el trabajo de fuerza de los músculos respiratorios.

**[FUTURE  
INVESTIGATIONS]**

In future investigations, a systematic review and meta-analysis of the existing literature about PA and its influence on people with chronic pulmonary diseases (COPD, asthma and ACO) all over the world should be developed. This aims to synthesize the available evidence on this topic to increase the validity of the conclusions reached in all the papers that compose this thesis, and to identify areas of uncertainty where it is necessary to continue investigating. It would be also convenient to corroborate the results obtained on this thesis with other studies that assess PA directly by using previously validated accelerometers.

Moreover, it is necessary to carry out longitudinal follow-up researches, applying different PA programs in people with the chronic pulmonary diseases presented in this thesis and low levels of PA. This way, their evolution could be observed and the most effective programs could be established. For example, a follow-up of a PA program using Nordic walking and another one based on resistance training of respiratory muscles could be considered.

# **FINANCIACIÓN Y CONFLICTO DE INTERESES**



La presente tesis doctoral ha sido posible gracias a las siguientes ayudas y contratos:

- Contrato predoctoral de Formación de Personal Investigador: 20773/FPI/18. Fundación Séneca. Región de Murcia (España).
- Ayudas para la realización de estancias externas destinadas a los investigadores predoctorales contratados con cargo al subprograma regional de contratos de formación de personal investigador. Fundación Séneca. Región de Murcia (España).

No hay conflicto de intereses (financieros, políticos, ideológicos, académicos, religiosos, comerciales o de cualquier otro tipo) que declarar en relación a esta tesis.

**[FUNDING AND COMPETING  
INTERESTS]**

This doctoral thesis has been possible thanks to the following grants and contracts:

- Predoctoral contract for Research Staff Training: 20773/FPI/18. Seneca Foundation. Región of Murcia (Spain).
- Grants for research stays abroad for predoctoral researchers hired under the regional subprogram for training contracts for research staff. Seneca Foundation. Región of Murcia (Spain).

There are no competing interests (financial, political, ideological, academic, religious, commercial or any other) to declare in relation to this thesis.

**ANEXOS**

**[ANNEXES]**

## ANEXO 1: Informe favorable del Comité de Ética de la Universidad de Murcia

UNIVERSIDAD DE  
MURCIA | Vicerrectorado de  
Investigación y Transferencia

CEI Comisión de  
Ética de  
Investigación

CAMPUS MARE NOSTRUM

**INFORME DE LA COMISIÓN DE ÉTICA DE INVESTIGACIÓN  
DE LA  
UNIVERSIDAD DE MURCIA**

Jaime Peris Riera, Catedrático de Universidad y Secretario de la Comisión de Ética de Investigación de la Universidad de Murcia,

CERTIFICA:

Que D.<sup>a</sup> Sheila Sánchez Castillo ha presentado la memoria de trabajo de la Tesis Doctoral titulada "*Influencia de la actividad física en la prevención y el tratamiento de la Enfermedad Pulmonar Obstructiva Crónica (EPOC)*", dirigida por D. Arturo Díaz Suarez, a la Comisión de Ética de Investigación de la Universidad de Murcia.

Que dicha Comisión analizó toda la documentación presentada, y de conformidad con lo acordado el día diez de abril de dos mil diecinueve<sup>1</sup>, por unanimidad, se emite INFORME FAVORABLE, desde el punto de vista ético de la investigación.

Y para que conste y tenga los efectos que correspondan firmo esta certificación con el visto bueno del Presidente de la Comisión.

Vº Bº  
EL PRESIDENTE DE LA COMISIÓN  
DE ÉTICA DE INVESTIGACIÓN DE LA  
UNIVERSIDAD DE MURCIA

Fdo.: Francisco Esquembre Martínez

ID: 2403/2019

<sup>1</sup>A los efectos de lo establecido en el art. 19.5 de la Ley 40/2015 de 1 de octubre de Régimen Jurídico del Sector Público (B.O.E. 02-10), se advierte que el acta de la sesión citada está pendiente de aprobación



Código seguro de verificación: RUXFMrxs-IB14RpvL-GQ+gphZH-1YQtksUC

COPIA ELECTRÓNICA - Página 1 de 1

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ANEXO 2: Factor de Impacto de las revistas en las que se han publicado los artículos.

**Table 2.** Impact Factor and quartile of the journals in which the papers of this thesis have been published, according to Journal Citation Reports (JCR).

<b>Journal</b>	<b>Year of P.</b>	<b>IF*</b>	<b>Q*</b>	<b>Category</b>
Lung	2019	2.584	Q4	Respiratory System
International Journal of Environmental Research and Public Health	2020	3.390	Q1	Public Environmental & Occupational Health
Medicina	2020	2.430	Q2	Medicine, general & Internal
Sustainability	2020-2021	3.251	Q2	Environmental studies
Journal of asthma	2021	2.515	Q3	Respiratory System

*\*Updated 2020. Year of P: Year of Publication IF: Impact Factor; Q: Quartile.*

## Anexo 3: Primera página artículo I

Lung (2019) 197:769–775  
<https://doi.org/10.1007/s00408-019-00287-4>

COPD



## Physical Activity Behaviour in People with COPD Residing in Spain: A Cross-Sectional Analysis

Sheila Sánchez Castillo<sup>1</sup> · Lee Smith<sup>2</sup> · Arturo Díaz Suárez<sup>1</sup> · Guillermo Felipe López Sánchez<sup>1</sup>

Received: 18 July 2019 / Accepted: 19 October 2019 / Published online: 4 November 2019  
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### Abstract

**Purpose** Chronic obstructive pulmonary disease (COPD) represents a major public health problem due to its high prevalence, morbidity and health cost. It has been demonstrated that physical activity (PA) is one of the most beneficial measures to prevent chronic diseases. The aim of this study was to examine PA levels of adults with COPD residing in Spain, and to analyse the differences by sex, age, education, marital status, cohabiting, tobacco consumption, alcohol consumption and body mass index.

**Methods** A total of 615 adults aged 15 to 69 years participated in this study. Data from the Spanish National Health Survey 2017 were used. This survey included the short version of IPAQ to measure PA levels. PA was expressed in total volume (MET·min/week), classified as low, moderate and high, and analysed according to sample characteristics. Statistical significance was set at  $p < 0.05$  (CI = 95%).

**Results** Level of PA was higher in men than in women (1808.8 vs. 1575.6 MET·min/week;  $p = 0.016$ ), in those aged under 30 years than in those older than 60 years (2129.4 vs. 1381.4 MET·min/week;  $p = 0.047$ ) and in those who drank alcohol than in those who did not drink (1912.8 vs. 1248.2 MET·min/week;  $p = 0.004$ ). Also, underweight and obese participants participated in lower levels of PA than normal weight participants ( $p = 0.001$ ). When classifying PA level, a total of 37.9% had a low level, 47.5% had a moderate level and only 14.6% had a high level of PA ( $p < 0.001$ ).

**Conclusion** It is recommendable to implement programs to raise awareness of the importance and benefits of PA in the control of COPD, and these programs should focus on those with lower levels of PA.

**Keywords** Physical exercise · Lung disease · Public health · Adults

### Introduction

Chronic Obstructive Pulmonary Disease (COPD) represents an important challenge for public health because of its increasing prevalence, high morbidity and socioeconomic burden [1]. Moreover, a large body of literature shows that COPD is associated with a decline in patient's quality of life [2]. Indeed, currently COPD is the fourth cause of global

death [3, 4], and in 2012, more than 3 million people died because of COPD, representing 6% of all global mortality.

Spanish national data collected in the EPI-SCAN study found a COPD prevalence of 10.2% in people aged 40 to 80 years, with an unequal distribution between the sexes: 15.1% in men versus 5.7% in women [5]. This study defined COPD by the GOLD criteria where the ratio between forced expiratory volume in the first second ( $FEV_1$ ) and the forced vital capacity (FVC) is  $< 0.70$  post-bronchodilator use. Following these findings, it was extrapolated that a 2,185,764 people in Spain suffer from COPD [6]. Importantly, a total of 10% of primary care consultations, 40% of pneumology consultations and 7% of annual hospitalizations in Spain are owing to COPD. In those with COPD comorbidities, cardiovascular, metabolic, musculoskeletal and psychological comorbidities are high [7]. These comorbidities are likely driving the high rate of hospitalization. Therefore, in order

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## ANEXO 4: Primera página artículo II



International Journal of  
Environmental Research  
and Public Health



Article

## Associations between Physical Activity and Comorbidities in People with COPD Residing in Spain: A Cross-Sectional Analysis

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Received: 23 December 2019; Accepted: 15 January 2020; Published: 16 January 2020



**Abstract:** There is a high prevalence of comorbidities among patients with chronic obstructive pulmonary disease (COPD). Comorbidities are likely common in patients with any COPD degree and are associated with increased mortality. The aim of this study was to determine the prevalence of thirty-one different COPD comorbidities and to evaluate the association between physical activity (PA) levels in people with COPD residing in Spain. Cross-sectional data from the Spanish National Health Survey 2017 were analysed. A total of 601 adults (52.2% females) with COPD aged 15 to 69 participated in this study. PA (exposure) was measured with the International Physical Activity Questionnaire (IPAQ) short form and comorbidities (outcomes) were self-reported in response to the question “Have you ever been diagnosed with . . . ?” Multivariable logistic regression, in three different models, was used to assess this association. Results showed a high prevalence of comorbidities (94%), these being chronic lumbar back pain (38.9%), chronic allergy (34.8%), arthrosis (34.1%), chronic cervical back pain (33.3%), asthma (32.9%) and hypertension (32.8%) the most prevalent. Low PA level was significantly associated with urinary incontinence (2.115[1.213–3.689]), chronic constipation (1.970[1.119–3.459]), cataracts (1.840[1.074–3.153]), chronic anxiety (1.508[1.002–2.269]) and chronic lumbar back pain (1.489[1.044–2.125]). Therefore, people with COPD should increase their PA levels in order to reduce their risk of comorbidities and increase their quality of life.

**Keywords:** lung disease; physical exercise; prevalence; adults

### 1. Introduction

COPD (chronic obstructive pulmonary disease) is an important challenge for public health. Its increasing prevalence, high morbidity and socioeconomic burden are some examples of its importance [1]. Moreover, a large body of literature shows that COPD is associated with a decline in a patient’s quality of life [2]. COPD is the fourth largest cause of global death [3,4] and will become the third by 2020. In 2012, greater than three million people died because of COPD (6% of all global mortality).

In Spain, the prevalence of COPD in people aged 40 to 80 was found to be 10.2%, being higher in men (15.1%) than in women (5.7%). [5]. This study used the definition of COPD proposed by the GOLD criteria, where the ratio between forced expiratory volume in the first second (FEV1) and forced vital capacity (FVC) is less than 0.70 post-bronchodilator. Considering these findings, it was extrapolated that 2,185,764 people in Spain suffer from COPD [6]. A total of 10% of primary care consultations, 40% of pneumonology consultations and 7% of Spanish annual hospitalizations are due to COPD. Moreover, in people with COPD comorbidities, the most prevalent comorbidities are cardiovascular, metabolic, musculoskeletal and psychological comorbidities [7]. The presence of



## ANEXO 5: Primera página artículo III



Article

## Levels of Physical Activity in Spanish Asthmatics: A Cross-Sectional Study

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Received: 27 October 2020; Accepted: 23 November 2020; Published: 25 November 2020

**Abstract:** *Background and objectives:* 339 million people in the world suffer from asthma. Regular physical activity (PA) could help in its control. Therefore, the aim of this research was to determine the level of PA in Spanish people with asthma considering variation by, age, sex, education, marital status, living together, smoking habits, alcohol intake and body mass index (BMI). *Materials and Methods:* 1014 Spanish people from 15 to 69 years were included in the study. Data of the Spanish Health Survey (year 2017) were analysed. PA levels were measured with the international physical activity questionnaire short version (IPAQ-SF). PA was categorized as low, moderate and high, and analyzed by sample characteristics. Mann-Whitney U test, Kruskal Wallis H and crosstabs were used to calculate statistical significance ( $p < 0.05$ ). *Results:* On average, Spanish asthmatics engaged in a weekly volume of 2228.9 metabolic equivalent of task (MET)·min/week. Males revealed significantly higher PA than females (2516.8 vs. 2019.5 MET·min/week;  $p = 0.005$ ), younger participants (<30 years) compared to people aged 30–60 years and older than 60 years (2699.0; 2243.2; 1619.3 MET·min/week;  $p < 0.001$ ) and those with tertiary level of education than those without secondary (2368.3 vs. 2168.3 MET·min/week;  $p = 0.001$ ). Level of PA was lower in those married ( $p = 0.001$ ) and/or living together ( $p = 0.010$ ). Alcohol consumers showed a higher level than the participants who did not drink (2378.3 vs. 1907.9 MET·min/week;  $p = 0.001$ ), but no significant differences were found within current, past and never smokers ( $p = 0.890$ ). Obese asthmatics engaged in less PA than their normal weight and overweight peers ( $p < 0.001$ ). Overall, moderate level was significantly the most frequent (47.7%), but 31.6% showed a low level. *Conclusions:* Three out of ten Spanish people with asthma do not achieve PA recommendations, so PA programs should be executed to make people aware of its benefits in asthma control, focusing on those groups with lower PA levels.

**Keywords:** respiratory disease; physical exercise; epidemiology; tobacco; body mass index; alcohol

### 1. Introduction

Asthma is a common and important chronic disease that involves people of all ages [1]. Globally, 339 million people suffer from asthma [2]. In adults, the overall prevalence diagnosed is estimated to be 4.3% [3]. In Spain, an epidemiological study of chronic obstructive pulmonary disease (IBERPOC Project), found a 4.9% prevalence of asthma in Spanish adults aged from 40 to 69 years [4], but according to data of the Spanish Health Survey (year 2017), the prevalence of asthma in Spanish people aged 15 to 69 years was found to be slightly higher, at around 6% [5].

Asthma is a chronic condition that appears with chronic airway inflammation, whose main symptoms are wheeze, chest tightness, shortness of breath, variable expiratory airflow limitation and cough [1]. All these aspects, together with the fear of having exercise-induced bronchoconstriction

## ANEXO 6: Primera página artículo IV



Article

## Analysis of Physical Activity and Comorbidities in Spanish Asthmatics

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Received: 21 May 2020; Accepted: 26 June 2020; Published: 29 June 2020

**Abstract:** The prevalence of comorbidities in asthmatics is high. Comorbidities may complicate the clinical management of asthma, increasing the risk for exacerbation and even death. The objective of the present research was to establish the prevalence of 31 asthma comorbidities and to assess the association of these comorbidities with physical activity (PA) in Spanish asthmatics. Data of the Spanish National Health Survey 2017 (cross-sectional design) were used in this study. A total of 1014 people (42.1% males) with asthma participated in this study (age range 15–69 years). The IPAQ (International Physical Activity Questionnaire) short form was the instrument administered to evaluate PA (exposure), and the self-reported answer to the question “Have you ever been diagnosed with...?” determined the presence of comorbidities (outcomes). This association was assessed by multivariable logistic regression. Results demonstrated a huge presence of comorbidities (89.3%). The most prevalent were chronic allergy (61.1%), chronic lumbar pain (28.7%), chronic cervical pain (24.2%), high cholesterol (20.9%), Chronic Obstructive Pulmonary Disease (COPD) (19.4%), migraine (19.2%) and hypertension (19.3%). PA level under 600 metabolic equivalent of task (MET)-min/week showed a significant association with urinary incontinence (3.10 [1.62–5.94]), osteoporosis (1.90 [1.00–3.61]) and chronic anxiety (1.69 [1.13–2.53]). Therefore, comorbidities and PA levels should be considered in the prevention and treatment of asthmatics, in order to improve their quality of life.

**Keywords:** respiratory health; exercise; prevalence; adults

### 1. Introduction

Asthma is a frequent and potentially serious chronic condition that affects all age groups [1]. Over 339 million people worldwide are affected by asthma [2]. According to previous research, the worldwide prevalence of asthma diagnosed in the adult population is 4.3% [3]. In Spain, the epidemiological study of chronic obstructive pulmonary disease (IBERPOC) found a prevalence of 4.9% in adults aged 40–69 years [4], and according to the Spanish National Survey 2017, a prevalence of 6% was found in Spanish people aged 15–69 years [5].

Chronic airway inflammation related to wheezing, chest tightness, shortness of breath, cough and variability in expiratory airflow limitation are some of the symptoms present in asthmatics. An insufficient control of asthma symptoms is a risk factor to develop crisis relating to asthma [1]. The previous aspects, together with the possibility of having EIB (exercise-induced bronchoconstriction), could reduce physical activity (PA) levels in asthmatics [6]. Therefore, asthmatics are usually involved in lower levels of PA in comparison with non-asthmatics [6,7]. In people with asthma, regular PA may be useful in the control of asthma [8–10]. Several studies suggest that regular PA reduces asthma symptoms [11,12], airway

## ANEXO 7: Primera página artículo V

JOURNAL OF ASTHMA  
<https://doi.org/10.1080/02770903.2021.1888977>



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## Physical activity behavior in people with asthma and COPD overlap residing in Spain: a cross-sectional analysis

Sheila Sánchez Castillo, MS<sup>a</sup>, Lee Smith, PhD<sup>b</sup>, Arturo Díaz Suárez, PhD<sup>a</sup> and Guillermo Felipe López Sánchez, PhD<sup>a</sup>

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### ABSTRACT

**Objectives:** To identify levels of physical activity (PA) among the Spanish population with asthma and chronic obstructive pulmonary disease overlap (ACO). A further aim was to analyze differences in PA levels by sex, age, education, marital status, cohabiting, smoking habits, alcohol consumption and body mass index (BMI).

**Methods:** In this cross sectional study, data from the Spanish National Health Survey 2017 were analyzed. A total of 198 people with ACO aged 15–69 years were included in the analyses. The short version of the international physical activity questionnaire (IPAQ) was used to measure total PA (MET-min/week). PA was further classified as low, moderate and high, and analyzed according to sample characteristics. Data were analyzed using the Mann-Whitney U test, Kruskal-Wallis H test and chi squared test. Statistical significance was set at  $p < 0.05$ .

**Results:** People with ACO engaged in a mean volume of 2038.1 MET-min/week. Those aged 30–60 years and those with normal weight were significantly more active than those aged  $\geq 60$  and those with obesity. When classifying PA level in low, moderate and high, results showed no significant differences between sample characteristics. Overall, moderate and high levels of PA were the most and least frequent levels (48.0% and 16.2%, respectively).

**Conclusions:** More than three out of ten Spanish adults with ACO do not achieve PA recommendations. Therefore, it is recommended to implement programs that promote the importance and benefits of PA among the Spanish population with ACO, and such programs should focus on older adults and those who are obese.

### ARTICLE HISTORY

Received 22 October 2020

Revised 28 January 2021

Accepted 2 February 2021

### KEYWORDS

Epidemiology; obesity; physiological disorders; prevention; quality of life

### Introduction

Asthma and chronic obstructive pulmonary disease (COPD) are two of the five major respiratory diseases, established by the Forum of International Respiratory Societies (FIRS) (1). Both of these conditions are important public health problems owing to their increasing prevalence, high morbimortality and socio-economic burden (2,3). In 2019, the Global Burden of Disease (GBD) study found a worldwide prevalence of asthma and COPD in the general population of 3.50% (3.40% males, 3.60% females) and 2.85% (2.85% males, 2.86% females), respectively (4). A previous analysis of the GBD study in 2015 (5) identified a 44.2% increased prevalence and an 11.6% increased risk or mortality from COPD between 1990 and 2015. In relation to asthma, the prevalence increased by 12.6% but mortality decreased by 26.7% between 1990

and 2015. Moreover, both asthma and COPD showed a decrease in age-standardised death and prevalence during this time-period.

These diseases are characterized by chronic respiratory symptoms and airflow limitation, but there are some differences between them. Symptoms of asthma vary over time in intensity and improve with the use of bronchodilators or even spontaneously, so expiratory airflow limitation is variable (2). COPD is characterized by persistent expiratory airflow limitation and respiratory symptoms with or without bronchodilator reversibility (3). Moreover, the onset of asthma tends to be before the age of 40 years while COPD is normally after 40 years and generally in those who have history of smoking or other toxic exposure. A systematic review and meta-analysis on the global burden of COPD found a prevalence of COPD of

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## ANEXO 8: Primera página artículo VI



Article

## Association between Physical Activity and Comorbidities in Spanish People with Asthma-COPD Overlap

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**Abstract:** Asthma and chronic obstructive pulmonary disease (COPD) are important conditions which often coexist. Higher rates of comorbidities among people with asthma-COPD overlap (ACO) may complicate clinical management. The aim of this study was to determine the prevalence of 30 different comorbidities and to analyze associations between these comorbidities and physical activity (PA) in Spanish people with ACO. Cross-sectional data from the Spanish National Health Survey 2017 were analyzed. A total of 198 Spanish people with ACO aged 15–69 years (60.6% women) were included in this study. PA was measured with the International Physical Activity Questionnaire (IPAQ) short form. Diagnosis of chronic conditions were self-reported. Associations between PA and comorbidities were analyzed using multivariable logistic regression models. The most prevalent comorbidities were chronic allergy (58.1%), chronic lumbar pain (42.4%), chronic cervical pain (38.4%), hypertension (33.3%) and arthrosis (31.8%). A PA level lower than 600 MET·min/week was significantly associated with urinary incontinence (OR = 3.499, 95% CI = 1.369–8.944) and osteoporosis (OR = 3.056, 95% CI = 1.094–8.538) in the final adjusted model. Therefore, the potential influence of PA on reducing the risk of these conditions among people with ACO should be considered, not only because of the health benefits, but also because PA can contribute to a more sustainable world.

**Keywords:** respiratory conditions; exercise; sustainability; multimorbidity



**Citation:** Sánchez Castillo, S.; Smith, L.; Díaz Suárez, A.; López Sánchez, G.F. Association between Physical Activity and Comorbidities in Spanish People with Asthma-COPD Overlap. *Sustainability* **2021**, *13*, 7580. <https://doi.org/10.3390/su13147580>

Academic Editor: José Carmelo Adsuar Sala

Received: 7 June 2021  
Accepted: 2 July 2021  
Published: 7 July 2021

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### 1. Introduction

The Forum of International Societies (FIRS) established chronic obstructive pulmonary disease (COPD) and asthma as two of the five major respiratory diseases [1]. Both conditions are important public health problems based on their high prevalence, socioeconomic burden and morbimortality [2,3]. The Global Burden of Disease (GBD) 2019 [4], revealed a global prevalence of asthma of 3.5% (3.6% females; 3.4% males) and 2.8% of COPD (2.8% females; 2.8% males). Moreover, COPD was accountable for 5.8% of global deaths in 2019 and asthma 0.82% [4]. Importantly, both diseases result in a high socioeconomic burden [5,6].

These respiratory conditions are characterized by airflow limitation and respiratory symptoms, but there are differences between them that need to be noted. In asthma patients, expiratory airflow limitation and symptoms such as wheeze, shortness of breath, cough and chest tightness vary over time in intensity and improve with the use of bronchodilators or even spontaneously [2]. However, COPD is characterized by persistent expiratory airflow limitation and persistent respiratory symptoms, with or without bronchodilator reversibility [3]. Onset of COPD tends to occur after 40 years and generally in those who have been exposed to noxious particles or gases, like tobacco. However, some patients have clinical features of both asthma and COPD [2]. These clinical phenotypes have been named as Asthma-COPD overlap (ACO) or asthma + COPD. Previous studies have used the term Asthma-COPD overlap Syndrome (ACOS) to describe these patients [7,8], but the latest updates of GINA [2] and GOLD [3] have named these clinical phenotypes Asthma-COPD