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Nutritional status and physical inactivity in moderated asthmatics

A pilot study

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Abstract

Preservation of nutritional status and of fat-free mass (FFM) and/or preventing of fat mass (FM) accumulation have a positive impact on well-being and prognosis in asthma patients. Physical inactivity is identified by World Health Organization as the fourth leading risk factor for global mortality. Physical activity (PA) may contribute to limit FM accumulation, but little information is available on the interactions between habitual PA and body composition and their association with disease severity in asthma severity.

Associations between habitual PA, FM, FFM, and pulmonary function were investigated in 42 subjects (24 patients with mild-moderate asthma and 18 matched control subjects). Sensewear Armband was used to measure PA and metabolic equivalent of tasks (METs) continuously over 4 days, while body composition was measured by bioelectrical impedance analysis. Respiratory functions were also assessed in all study participants.

FM and FFM were comparable in mild-moderate asthmatics and controls, but PA was lower in asthmatics and it was negatively correlated with FM and positively with the FFM marker body cell mass in all study subjects ($P<0.05$). Among asthmatics, treated moderate asthmatics (ICS, n = 12) had higher FM and lower PA, METs, steps number/die, and forced expiratory volume in the 1st second (FEV1)/forced vital capacity (FVC) than in untreated intermittent asthmatics (UA, n = 12).

This pilot study assesses that in mild-moderate asthma patients, lower PA is associated with higher FM and higher disease severity. The current results support enhancement of habitual PA as a potential tool to limit FM accumulation and potentially contribute to preserve pulmonary function in moderate asthma, considering the physical inactivity a strong risk factor for asthma worsening.

Abbreviations: A = Mild moderate asthmatics, ACQ = Asthma control questionnaire, ACT = Asthma control test, BCM = Body cell mass, BCMI = Body cell mass index, BIA = Bioelectrical impedance analysis, BMI = Body mass index, C = Controls subjects, ECW = Extracellular water, FEV1 = Forced expiratory volume in the 1st second, FFM = Fat-free mass, FFMI = Fat-free mass index, FM = Fat mass, FMI = Fat mass index , FVC = Forced vital capacity, GINA = The global initiative for asthma, ICS = Treated moderate asthmatics, ICW = Intracellular water, IQR = interquartile range, METs = metabolic equivalent tasks, MM = Muscle mass, MMI = Muscle mass index, NCDs = Noncommunicable diseases, SWA = SenseWear Armband , TBW = Total body water, UA = Untreated intermittent asthmatics.

Keywords: armband, asthma, body composition, fat mass, physical activity

1. Introduction

Nutrition and metabolism have been a major topic of increasing scientific research in respiratory diseases mainly because physical activity (PA) and diet are important and interrelated lifestyle factors not only for disease prevention but also contributing to heterogeneity in disease progression and prognosis.[1] The nutritional interest in lung diseases, such as chronic obstructive pulmonary disease (COPD) and lung cancer, has been traditionally on muscle wasting (cachexia) in advanced disease stages and

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negative interactions between fat accumulation and muscle wasting have been also recently recognized.[2,3] Particularly musculoskeletal impairment and excess to the fat mass (FM) contribute to increased morbidity and mortality in COPD patients and the current insight provides sufficient rationale for integrating lifestyle intervention, including smoking cessation, a healthy diet, and a physical active lifestyle.[4] Individuals who are physically active have numerous physical and mental health benefits and a better perceived health status than those who are not. The World Health Organization now identifies physical inactivity as the fourth leading risk factor for global mortality with major implications for the prevalence of noncommunicable diseases (NCDs) and the general health of the population worldwide.[5] The NCDs represents a wide number of chronic inflammatory disease that have in common an underlying low-grade inflammation, including the early-onset NCDs, such as allergy and asthma.[6] Asthma is a complex lung inflammatory disorder for its multifactorial nature, including both a neuro-muscular component (bronchospasm) and an immunological component (inflammation).[7] Asthma entities are classified as intermittent and persistent (from mild to severe) and this classification considers symptoms, pharmacological treatment, frequency of exacerbations, PA limitations, and pulmonary function.[8] The goal for asthma treatment should be an integrative approach, including the nonpharmacological treatments such as nutrition and PA modifications, particularly aerobic and breathing exercises.[9] Literature indicates that PA may favorably modulate body composition by counteracting the extent of skeletal muscle loss and by reducing FM,[10–12] but the role of daily PA as a protective measure is still controversial and a matter of debate. Sensewear Armband (SWA) is a versatile validated monitor of PA level already used in pulmonary patients.[13,14] Bioelectrical impedance analysis (BIA) is conversely a noninvasive and effective technique to measure body composition.[15,16] To our knowledge, no information is available on potential interactions between daily PA, body composition, and pulmonary function in asthma patients, mainly at early and less clinically severe stages of the disease. We therefore investigated the relevance of daily PA levels in relationship to body composition and pulmonary function. In particular, we tested the hypothesis that habitual PA would be lower in asthma patients and that lower PA would be associated with lower fat-free mas and/or higher FM as well as worse pulmonary function.

2. Methods

2.1. Study design, subjects enrolled, and sensewear armband (SWA)

All subjects recruited (40.5 years; M = 35.71%) in a period of 6 months included 24 mild-moderate asthmatics (A, 12 with untreated intermittent UA and 12 with moderate treated asthma ICS) and 18 healthy matched subjects (C), were derived from the immunopathology unit (IBIM) at the National Research Council (CNR) a secondary care referral center in Palermo, Italy. All subjects enrolled were instructed to continuously wear the SWA for 4 days. In this experimental protocol, weekend data were included in all cases to obtain a more complete data set of the global activity. All asthma patients were recruited according to the American Thoracic Society criteria.[17] Asthma entities were defined according to the GINA guidelines.[8] The UA group includes subjects who received inhaled short-acting ß2-agonists as needed. The ICS group included subjects who required a high daily dose of inhaled corticosteroids (1000 μg of fluticasone or equivalent), long-acting ß2-agonists (100 μg salmeterol or equivalent), and inhaled short- acting ß2-agonists for a well-controlled asthma as required. All asthmatics and healthy volunteers were nonsmokers. Subjects who had any persistent environmental trigger, COPD, or bronchial or respiratory tract infections were excluded from the study. The study fulfilled the criteria of the reference Ethic Committee of *Policlinico-Giaccone* Hospital-Palermo Italy (authorization reference number 7/2013) and was in agreement with the Helsinki Declaration. All subjects gave their written informed consent. Subjects were instructed on how to apply the portable SWA and informed that SWA should be worn at all times except in the case of contact with water. SWA (HealthWear, BodyMedia, Inc., Pittsburgh, PA) is a device that measures a heat flux sensor, a galvanic skin response sensor, a skin temperature sensor, and a near-body ambient temperature sensor to capture data, by using a 2-axis accelerometer. SWA was placed on the upper right arm over the triceps brachii muscle at the midpoint between the acromion and olecranon processes[18] and data were computed in 1-minute interval. Data including body weight, height and handedness are used to calculate the total energy expenditure in 24 hours (TEE) as well as the duration (in minutes) and the intensity (in energy expenditure, kcal) of daily PA level, as defined by metabolic equivalent tasks (METs).[12] METs provide a measure of the energy expenditure in multiples of the resting energy expenditure (REE) where the rate of oxygen uptake during rest is defined as 0.9 MET. METs were quantified as low (METs <3), moderate ($3<$METs<6), and vigorous (METs >6).

2.2. Objective measures

2.2.1. Bioelectrical impedance analysis (BIA), respiratory functions, olfactory function, and skin prick test.

BIA is a safe, noninvasive method that determinates the body composition by an electric current passing through the body. All subjects were analyzed with a single frequency (50 kHz) analyzer Akern BIA 101 (Akern RJL Systems, Florence, Italy). It gives a vector BIA, via an individual impedance vector compared with the 50, 75, and 95% tolerance ellipses calculated in the reference, healthy population, allowing evaluation in any clinical condition.[16] Subjects were positioned supine on a nonconductive surface with their arms and legs abducted at 30° throughout and electrodes (Akern) were placed on the dorsum of the hand, wrist, ankle, and foot of the dominant side of the body.[19] The electric impedance consists of 2 components, resistance (R), a direct measure of total body water (TBW), and reactance (Xc), a direct measure of body cellular mass (BCM). Phase angle, expressed as degree, is calculated as the ratio of resistance over reactance providing direct information on cellular mass and integrity. The TBW included the extracellular water (ECW) and the intracellular water (ICW), and the BCM represents the cells that have an effect on metabolism, as muscle and nervous system. BCM and TBW together with anthropometric and personal patient's data are used to give other estimated parameters, including the FM and the fat-free mass (FFM). BMI (expressed as kg/m^2), BCMI (expressed as BCM/m^2), FMI (expressed as FM/m^2), and FFMI (expressed as FFM/m^2) are also estimated. Pulmonary function spirometric measurements, including forced expiratory volume in the first second (FEV1) and forced vital capacity (FVC), were performed by a microQuark spirometer (COSMED SRL, Rome, Italy). The olfactory function was blinded tested by the Sniffin' Sticks 12-item odor identification test (Burghardt, Wedel, Germany). It consists in 12 pen-like odor-dispensing devices, presented in a randomized sequence that subjects were allowed to sample one time before identifying them in a multiple-choice form. The test score, from 0 (worst) to 12 (best), was the sum of the correctly identified odors.[20] Peak nasal inspiratory flow (PNIF) was also performed and the best of 3 inhalations was recorded.[20] Atopy to inhalants was studied using skin allergy prick tests (SPTs; Alk Abellò, H⊘rsholm, Denmark) and the following allergens were tested: dermatophagoides pteronyssinus and farinae, dog, artemisia, olive, alternaria, birch, blattella, parietaria judaica, cat, timothy grass, and grass mix.

2.3. Subjective measures

2.3.1. Asthma and allergic rhinitis questionnaires.

Asthmatic patients used 2 validated questionnaires, Juniper Asthma Control Questionnaire (ACQ)[21] and Asthma Control Test (ACT)[22] to collect the composite scores and to assess the entities and the perception of asthma. The visual analog scale (VAS) was administered in asthmatics to evaluate the severity of allergic rhinitis of global rhinitis symptoms.[23] It grades symptoms on a 10-cm line: zero (at the left end of the line) represents no complaints and 10 (at the right end) represents the worst possible symptoms.

2.4. Statistical analysis

Means and standard deviations or medians and interquartile ranges (IQRs) were calculated for continuous data (for normally and not normally distributed variables, respectively) and percentages for categorical data. A nonparametric Mann–Whitney test was applied between 2 groups. A contingence table raw data for atopy difference were used. Correlations were determined by a Spearman rank correlation test. All computations were performed by StatView statistical software package (SAS Institute, Cary, NC). A P value <0.05 was considered statistically significant.

2.4.1. Power of the study. The differences and standard deviation of ICW between controls and all the included asthmatics indicate a sample size of 10 replicates for a power of the study >80% and with an alpha error of 5%.

3. Results

3.1. Body composition, SWA data, and correlations, in all subjects

ICW and PA, both in terms of minutes and intensity, were significantly lower (p=0.04 and p=0.001, respectively) in asthmatics and controls, whereas BMI, BCM, MM, FFM, and phase angle were not significantly different in asthmatics versus controls (Tables 1 and 2 and Fig. 1A, B). FM linear regression analysis was significantly inversely associated with minutes of PA (Rho=-0.37, P=0.018), whereas FEV1/FVC was significantly inversely associated with FM (Rho=-0.518, P=0.001) and positively associated with METs (Rho=0.34, P=0.028) (Fig. 2A–C). On the contrary, both the intensity of PA (KCAL) and the TEE (KCAL/die) were significantly positively associated with BCM (Rho=0.38 and P=0.01 and Rho=0.696, P=0.0001), phase angle (Rho=0.30 and P=0.03 and Rho=0.31, P=0.040), FFM (Rho=0.50 and P=0.0019 and Rho=0.82, P=0.0001), and ICW (Rho=0.0397 and P=0.01 and Rho=0.496, P=0.001) (Fig. 3A–D, data not shown for TEE).

3.2. Body composition and SWA data in asthma patient subgroups

All data are presented in Table 3. Particularly, BMI and FM were significantly lower in UA than in both ICS and C (P=0.005 and P=0.01, respectively) (Fig. 4A). On the contrary, PA (both minutes and intensity) as well METs were significantly lower in ICS than in UA (P=0.002, P=0.02, P=0.004) and C (P=0.0008, P=0.01, P=0.02) (Fig. 4B–D). Furthermore, the step numbers in UA were significantly higher (p=0.04) than in ICS (Figure 4E). No significant differences were detected in SWA wearing and in all the other parameters obtained by SWA (data not shown).

3.3. Respiratory parameters, atopy, and symptom scores

As expected, FEV1 values were significantly lower, whereas atopy parameters were significantly higher in asthmatics than in controls (P=0.0009 and P=0.0001, respectively) (Table 4). In

Table 1

Demographic characteristics and bioelectrical impedance data.

	Normal control Healthy volunteers (C, 18)	Mild moderate asthmatics (A, 24)	P value (Mann–Whitney*)
Age (y, mean ± SD)	43.1 ± 14.3	38.5 ± 14.2	0.4
Sex (M/F ratio)	45%	34%	0.5
Weight, kg (mean ± SD)	71.3 ± 18.5	72.2 ± 19.6	0.9
Height, m (mean ± SD)	1.65 ± 0.9	1.67 ± 0.9	0.6
Body mass index (BMI) (median and IQR)	26.2 (4.6)	24.3 (7.7)	0.6
Body cellular mass (BCM) (median and IQR)	26.1 (14.2)	25.3 (9.4)	0.6
Body cellular mass Index (BCMI) (median and IQR)	9.8 (1.8)	9.5 (3.1)	0.8
Total body water (TBW), L (median and IQR)	36.8 (17.1)	36.3 (14.7)	0.6
Extracellular water (ECW), L (median and IQR)	16.6 (7.5)	17.3 (4.9)	0.6
Intracellular water (ICW), L (median and IQR)	27.8 (18.9)	18.8 (8.1)	**0.001***
Fat mass (FM), kg (median and IQR)	18.5 (13)	15.6 (25.2)	0.8
Fat mass index (FMI) (median and IQR)	6.5 (3.4)	6.3 (7.3)	0.9
Fat-free mass (FFM), kg (median and IQR)	48 (22.4)	48.5 (15.6)	0.6
Fat-free mass index (FFMI) (median and IQR)	18.5 (4.2)	17.6 (3.5)	0.2
Muscle mass (MM), kg (median and IQR)	32.0 (16.5)	31.3 (12.4)	0.7
Muscle mass index (MMI) (median and IQR)	11.9 (2.4)	11.3 (3.1)	0.4
Phase angle, degrees (mean ± SD)	5.8 ± 1.0	5.3 ± 0.6	0.1

Demographic characteristics and bioelectrical impedance data. Statistical significance between the 2 groups was evaluated by *Mann–Whitney test. IQR = interquartile range, SD = Standard deviation.

Table 2

SenseWear Armband (SWA) data.

	Normal control Healthy volunteers (C, 18)	Mild –moderate asthmatics (A, 24)	*P* value (Mann–Whitney*)
SWA wearing (h/die, median and IQR)	23.6 (1.6)	23.7 (0.5)	0.4
Physical activity, min/die (median and IQR)	93.2 (101)	69.7 (84.2)	**0.04***
Active energy expenditure, kcal/die (median and IQR)	486.7 (435)	335 (380)	**0.04***
METs/24 h (median and IQR)	1.6 (0.3)	1.5 (0.3)	0.4
TEE, kcal/die (median and IQR)	2572 (596.1)	2372 (1093.7)	0.6
STEPS, number/die (mean ± SD)	10,860.2 ± 3041.7	10,433.9 ± 3812.8	0.7
LAYER, h/die (median and IQR)	8.1 (1.4)	7.3 (1.5)	0.1
SLEEP, h/die (median and IQR)	6.5 (1.4)	5.9 (1.2)	0.08

Sensewear Armband (SWA) data. Statistical significance between the 2 groups was evaluated by *Mann–Whitney test. IQR = interquartile range, METs = metabolic equivalent tasks, SD = standard deviation, SWA = Sensewear Armband, TEE = total energy expenditure.

details, FEV1/FVC values were significantly lower in ICS than in C and in UA (Table 3) ($P=0.001$ and $P=0.007$, respectively), whereas no difference for atopy was found between UA and ICS (data no shown). Regarding the health-related quality-of-life questionnaires for asthmatics, the subjective measures such as ACQ, ACT, and VAS scores were significantly different in ICS than in UA ($P=0.036$, $P=0.032$, $P=0.034$) (Fig. 4F). Olfactory function, measured by objective measures such as PNIF and Sniffin' Sticks tests, were not different among the study groups.

4. Discussion

This study investigates the associations between habitual daily PA, body composition, and respiratory function in moderate asthma patients. We demonstrated that mild-moderate asthmatics compared with healthy subjects have significantly lower daily PA and significantly lower ICW; in the whole study population, PA is significantly inversely associated with FM and significantly positively associated with markers of lean mass, including FFM, BCM, phase angle, and ICW; pulmonary function is significantly inversely associated with FM and significantly positively associated with the METs. Associations between habitual daily PA and body composition support our working hypothesis that daily PA contributes to preserve a more favorable body composition pattern with lower fat accumulation and higher lean mass, potentially including preserved skeletal muscle tissue. No correlation was found between BMI and PA levels, thereby underlining the importance of characterizing body composition and markers of fat and lean body mass. As PA has been reported to modulate body composition,[10–13] our findings also support the concept that enhancing daily PA may contribute to preserve a more favorable nutritional status with higher lean and muscle mass and lower FM in patients with mild-moderate asthma. This conclusion is further strengthened by differences between asthma patient subgroups, with more severe treated asthmatic condition (ICS) showing higher FM in the presence of lower intensity and duration of PA and lower METs than less severe intermittent untreated patients (UA).

Asthma patients considered together had by design a mild-moderate disease severity that likely contributed to a lack of major alterations in fat and FFM in the study population as a whole. It is possible that more severe disease conditions as well as longer disease duration with more advanced age could also result in differences in average FFM and FM between patient and control groups. Under the current study conditions, we however found significantly lower ICW in asthma patients than the control group. Our pilot study was also designed to investigate potential associations between respiratory function parameters, PA, and body composition. On the basis of this, a recent pilot study assesses the importance to monitor the walk intensity by a specific tool such as the clever exercise pedometer.[24] Interestingly, we found that pulmonary function parameters including FEV1/FVC are directly associated with PA in asthma patients. It is possible that lower respiratory function may directly limit activity levels, but moderate disease severity makes it unlikely that more impaired respiratory function is entirely responsible for the observed inverse association between activity levels and FEV1/FVC. It is conversely conceivable that lower PA may potentially

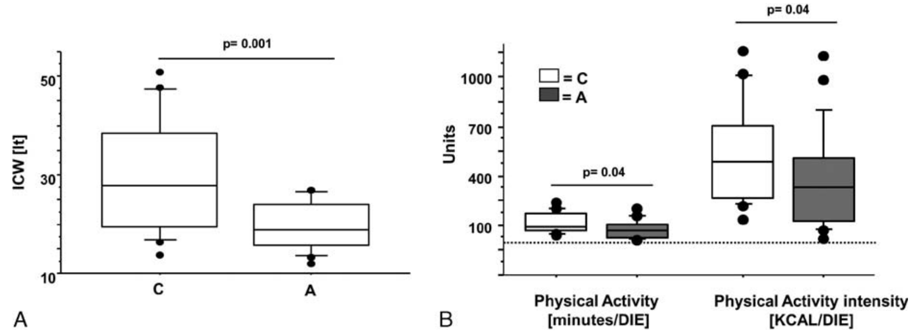

Figure 1. Intracellular water (ICW) and physical activity (duration/minutes and intensity/KCAL/die) were significantly lower in A (mild moderate asthmatics) than in C (control subjects) (A, B). Horizontal bars inside boxes represent the median values and limits of boxes represent the 25th and 75th percentiles. *P* values (inside the figure) represent the results of Mann–Whitney test.

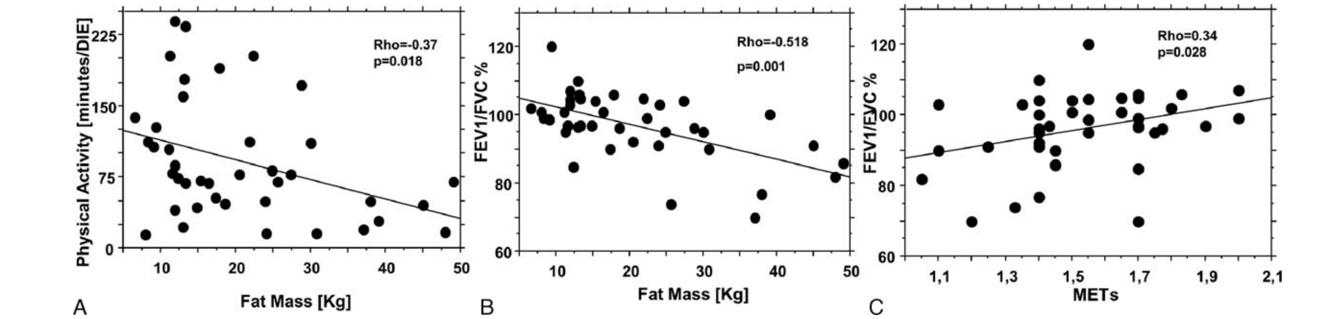

Figure 2. Fat mass (FM) significantly inversely correlated with the duration of physical activity and with FEV1/FVC (A, B). FEV1/FVC was significantly positively correlated with METs (metabolic equivalent tasks) (C). All Spearman's rank correlations (Results section). FEV1 = Forced expiratory volume in the 1st second, FVC = Forced vital capacity.

lead to worse respiratory function parameters in treated asthma patients, at least in part mediated by altered body composition. The untreated intermittent asthmatics had higher PA and lower FM than treated moderate asthmatics and on the basis of own asthma and nasal function perception, they could be considered as a control category. Nevertheless, the significantly decreased ICW also in the untreated intermittent asthmatics in comparison to the healthy subjects underlines an inflammatory status due to the asthma condition. In a previous study of 102 severe asthma patients, we accordingly demonstrated that excess FM plays a crucial role in asthma control and management.[25] In moderate asthma, enhancement of PA could therefore exert direct and indirect beneficial impact on disease severity. This hypothesis is also consistent with anti-inflammatory effects of PA,[26] as the protective effect of regular exercise against chronic inflammation may be explained in terms of reduction in body fat as well as enhancement of muscle mass. Also, in indirect agreement with these concepts, a recent study[27] of 2758 obese and nonobese children analyzed asthma incidence. The 2-year follow-up demonstrated that central obesity measures should be incorporated in childhood asthma risk predictions, and it concluded that children should be encouraged to increase their PA to prevent central obesity related asthma. It should be pointed out that previous studies also demonstrated that asthma patients with reported lower PA level show less tolerance to more vigorous exercise due to worsening perception of asthma symptoms during exercise,[28] and these phenomena may lead to a vicious cycle of impaired exercise and PA leading to altered body composition and further reduction in activity levels. A recent review[9] of 21 randomized trials of >8-year-old asthma patients (n = 772), randomized to undertake physical training for at least 20 minutes (twice/week) for 4 weeks, demonstrated that physical activity is well tolerated and significantly improves maximum oxygen uptake, without effects on other measures of pulmonary function.

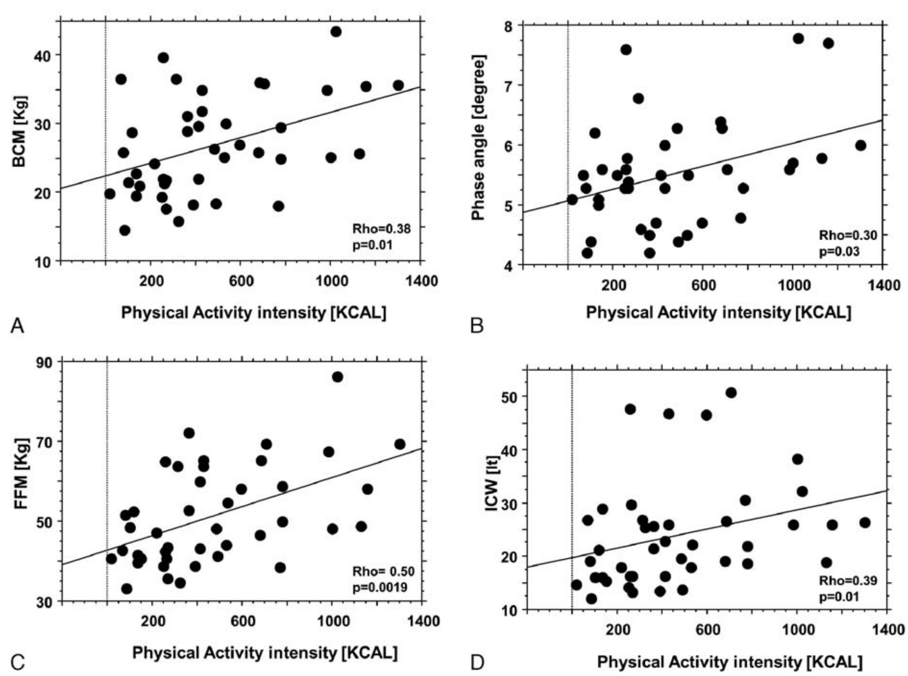

Figure 3. Physical activity (intensity/KCAL/die) in all 42 subjects is directly correlated to the health good status (A–D). All Spearman's rank correlations (Results section).

Table 3

Body composition, SenseWear Armband (SWA) data, and pulmonary function in asthma patient subgroups.

	Untreated intermittent asthmatics (UA, 12)	Moderate treated asthmatics (ICS, 12)	*P* value (Mann–Whitney*)
Weight, kg (mean ± SD)	62.7 ± 10.8	81.7 ± 22.1	**0.02***
Height, m (mean ± SD)	1.67 ± 0.1	1.65 ± 0.8	0.6
Body mass index (BMI) (median and IQR)	21.7 (4.5)	28.8 (11.6)	**0.006***
Body cellular mass (BCM) (median and IQR)	23.4 (9.1)	28.8 (9.2)	0.4
Body cellular mass index (BCMI) (median and IQR)	9 (2.5)	10 (3.5)	0.2
Total body water (TBW), L (median and IQR)	35.5 (11.8)	38.5 (14.7)	0.6
Extracellular water (ECW), L (median and IQR)	16.9 (5.8)	17.5 (4.8)	0.9
Intracellular water (ICW), L (median and IQR)	17.2 (6.6)	21.3 (8.5)	0.5
Fat mass (FM), kg (median and IQR)	13 (4.5)	37 (24.5)	**0.005***
Fat mass index (FMI) (median and IQR)	4.3 (3.8)	11.5 (10.1)	**0.007***
Fat-free mass (FFM), kg (median and IQR)	46.2 (16)	52.1 (15.6)	0.8
Fat-free mass index (FFMI) (median and IQR)	17.4 (3.1)	18.3 (4.3)	0.5
Phase angle, degrees (mean ± SD)	5.5 (0.7)	5.3 (0.7)	0.3
Physical activity, min/die (median and IQR)	109.2 (84.2)	37 (45.7)	**0.002***
Active energy expenditure, kcal/die (median and IQR)	419.2 (629.2)	202 (283.2)	**0.02***
METs/24 h (median and IQR)	1.6 (0.1)	1.4 (0.3)	**0.004***
STEPS, number/die (mean ± SD)	12,068.7 ± 3481.7	8799.12 ± 3527.5	**0.04***
FEV1/FVC (absolute %, mean ± SD)	101.5 ± 6.9	87 ± 11.1	**0.007***

Body composition, SWA data, and pulmonary function in asthma patient subgroups (untreated intermittent asthmatics, UA, and moderate treated asthmatics, ICS). Statistical significance between the 2 groups was evaluated by *Mann–Whitney test. FEV1 = Forced expiratory volume in the 1st second, FVC = Forced vital capacity, IQR = interquartile range, METs = metabolic equivalent tasks, SD = standard deviation, SWA = Sensewear Armband.

Regarding atopy, we found that it is higher in mild-moderate asthmatics than in controls, but not different between patient subgroups, suggesting that atopy does not influence per se physical activity patterns in asthma.

4.1. Study limitation

First, the study is a pilot with a limited sample size, which we have calculated and reported in the statistical analysis section. Furthermore, our data are derived from a cross-sectional study and cannot establish cause and effect. Nevertheless, we obtained a significant reduction of the PA level and of the ICW in all mild-moderate asthmatics in comparison to age, gender, and BMI-matched controls. Future longitudinal study and with a larger cohort is required to confirm these results.

5. Conclusions

Our study adds important additional information on the potential role of the physical inactivity and the high level of FM on worsening asthma symptoms and perception. We give novel information on the association between low levels of

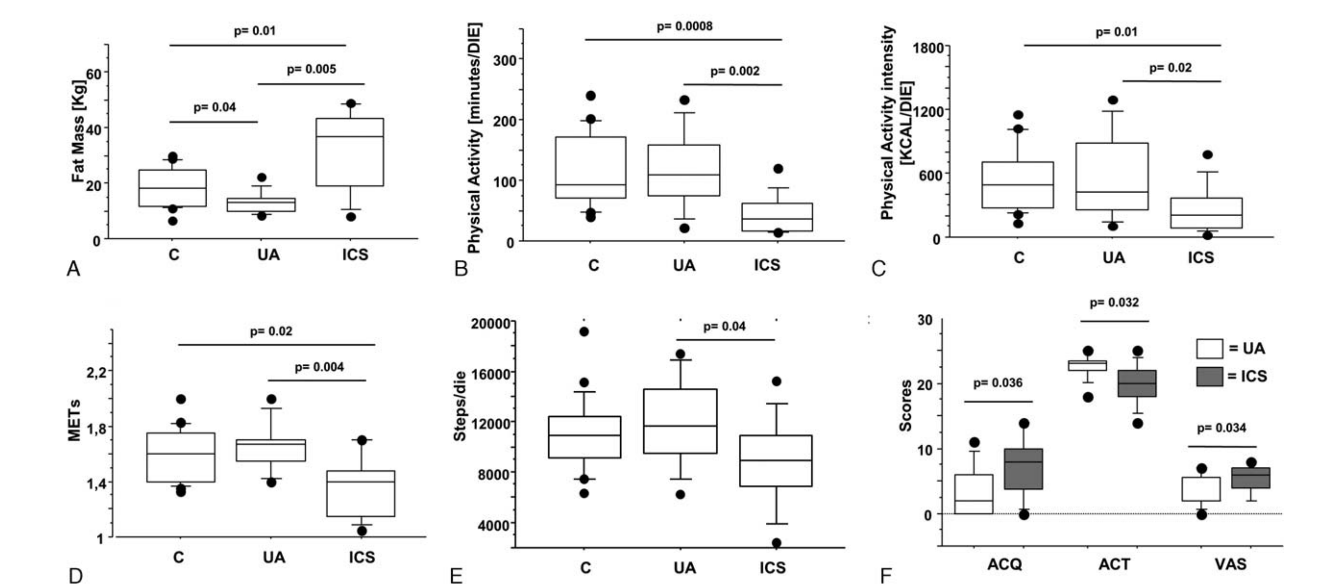

Figure 4. Fat mass (FM) (A), physical activity (duration/minutes and intensity/KCAL/die) (B, C), METs (metabolic equivalent tasks) (D), steps/die (E) in the 3 studied groups. ACQ (Juniper Asthma Control Questionnaire), ACT (Asthma Control Test), VAS (Visual Analog Scale) (F) in UA (untreated intermittent asthmatics), and ICS (moderate treated asthmatics). Horizontal bars inside boxes represent the median values and limits of boxes represent the 25th and 75th percentiles. *P* values (inside the figure) represent the results of Mann–Whitney test.

Table 4

Pulmonary parameters and trigger precipitating factors.

	Normal Control Healthy volunteers (C, 18)	Mild moderate asthmatics (A, 24)	*P* value (Mann–Whitney*)
FEV1, % of predicted (mean ± SD)	107.1 ± 13.1	89.2 ± 15.9	**0.0009***
FEV1/FVC, absolute %, (mean ± SD)	98.7 ± 8	94.2 ± 11.7	0.1
Allergic sensitization, % (atopy)	13	87.5	**0.0001***
Sniffin' Sticks test score (median and IQR)	11 (1)	10 (1)	0.4
Peak nasal inspiratory flow (PNIF) (L/min) (mean ± SD)	113.3 ± 39.1	101.4 ± 24.7	0.4

Pulmonary parameters and trigger precipitating factors. Statistical significance between the 2 groups was evaluated by *Mann–Whitney test. FEV1 = Forced expiratory volume in the 1st second, FVC = Forced vital capacity, IQR = interquartile range, SD = standard deviation.

habitual daily PA and higher FM with lower ICW in patients with mild-moderate asthma. These results strengthen the relationship among the severity of asthma, physical inactivity, and adipose tissue, leading to the concept that lower PA is associated with worse respiratory function markers and higher disease severity. In this scenario, as already assessed for COPD,[4] the research on metabolism and nutrition leads the need for a paradigm shift from reactive medicine toward predictive, preventive, personalized, and participatory (the so called P4) medicine, also for asthma. PA should be considered an indispensable factor for primary prevention for the health-related status and asthmatics should be encouraged to enhance habitual PA and to participate in regular exercise training, without the fear of symptom exacerbation, to limit their FM accumulation and potentially contribute to preserve their pulmonary function.

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