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Original Research

Identification and characterization of phenotypes based on behavior for physical exercise in adolescents with asthma: a multicenter study

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ABSTRACT

Background: Although physical exercise is largely recommended, sedentary lifestyle is common in people with asthma. Understanding the motivation to exercise in adolescents with asthma may help to promote exercise-related behavior change.
Objectives: To identify clusters based on Motivational Regulations (MR) and Basic Psychological Needs (BPN) for exercise and compare quality of life, asthma control, and disease severity across these clusters.
Methods: A cross-sectional and multicenter study in which adolescents with asthma were assessed for anthropometric measures, MR, and self-determination for exercise, as well as their perceptions regarding the fulfillment of autonomy, competence, and relatedness to exercise, quality of life, asthma control, and severity. Participants were classified by hierarchical cluster analysis based on MR and BPN. In addition, clusters were compared.
Results: A total of 144 participants with asthma aged 14 (SD: 2) years participated. Self-determination for physical exercise was 7.13 (7.88) points. Two clusters were identified: 1) More autonomous behavior and High Perceived Support (n=56) and 2) Less autonomous behavior and Low Perceived Support (n=88). Participants in Cluster 2 had worse quality of life than those in Cluster 1 [71 (SD: 15) vs 83 (SD: 15) points, respectively, P<0.0001] and a higher proportion of girls [50 (57%) vs 18 (32%); P=0.006, respectively). No significant differences were observed in the other variables between clusters.
Conclusions: The behavioral profile based on MR and BPN was identified in adolescents with asthma through cluster analysis. Females showed a greater association with Cluster 2, characterized by less autonomous behavior and low perceived support, and this cluster can negatively impact quality of life.

Introduction

Physical exercise is largely recommended for adolescents with asthma given its benefits in reducing systemic inflammation, enhancing exercise capacity, and improving asthma control.[1] Conversely, a sedentary lifestyle in this population is linked to poorer disease management and a decline in overall health.[2] Evidence also suggests that children with asthma engage in less physical activity than their non-asthmatic peers,[3-5] raising concerns about potential differences in motivation and exercise behavior.

Exercise behavior refers to the patterns and actions related to physical activity that individuals intentionally engage in for improving

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1413-3555/© 2026 Associação Brasileira de Pesquisa e Pós-Graduação em Fisioterapia. Published by Elsevier España, S.L.U. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

or maintaining physical fitness, health, or well-being. Beyond individual factors like frequency, intensity, duration, and type, exercise behavior is also influenced by psychological, social, and environmental determinants. Intrinsic motivation, social support from family and peers, and the accessibility of facilities and outdoor spaces play crucial roles in promoting an active lifestyle. Motivation influences performance in both healthy adolescents[6] and those with chronic respiratory diseases.[7] The Self-Determination Theory (SDT)[8,9] posits that human beings are driven by Amotivation, Extrinsic and Intrinsic Motivation. SDT analyzes the degree to which motivation is more or less self-determined, how different types of motivation lead to varying outcomes, and how social conditions support or hinder human well-being through basic psychological needs (BPN). Supporting the BPN of autonomy, competence, and relatedness fosters more intrinsic, autonomous motivation, which is fundamental for psychological well-being, enhancing behavioral engagement, and improving adherence to physical activity programs.[8,9]

Assessing motivation for exercise in adolescents with asthma is especially important, as this population faces the dual challenge of coping with psychological and physical changes during adolescence, alongside managing a chronic disease that can affect their social life.[10,11] Asthma symptoms often lead to physical and psychological difficulties, directly impacting daily activities and diminishing the quality of life.[12] While regular physical exercise plays a crucial role in asthma rehabilitation, low adherence and motivational challenges are frequently observed, despite its well-documented benefits.[13]

Given the importance of adopting and maintaining regular physical exercise in this population, it is essential to explore the role of behavioral factors, such as motivation. However, the current literature lacks studies investigating the behavioral profile of adolescents with asthma regarding their motivation for physical exercise. To date, to our knowledge, only one qualitative study, based on the SDT framework, has explored motivation for physical activity (PA) and exercise among adolescents with asthma.[14] This study revealed an amotivated profile for PA,[8,9] citing barriers like lack of asthma knowledge among teachers, embarrassment regarding asthma symptoms, inability to keep pace with peers, and seasonal challenges.[14] Similar barriers for PA have been reported in other studies.[15]

Thus, the objective of this study was to identify the behavioral profile for physical exercise in adolescents with asthma, to characterize clusters based on Motivational Regulations (MR) and Basic Psychological Needs (BPN) for exercise, and to compare quality of life, asthma control, and disease severity across these clusters.

Methods

This exploratory, observational, cross-sectional study was conducted at two centers in Brazil: São Paulo and Londrina. Participants were prospectively recruited between May 2021 and December 2022 during routine medical consultations at the Allergy, Clinical Immunology, and Rheumatology Outpatient Clinic, Pediatrics Department, Universidade Federal de São Paulo, and the Pulmonology Outpatient Clinic of the Clinical Hospital Universidade Estadual de Londrina. The recruitment was initially intended for a cross-cultural adaptation and validation study of a self-efficacy questionnaire (unpublished data).

All adolescents with asthma were evaluated during a single face-to-face visit, after obtaining written informed consent from their legal guardians and the adolescents' own signatures on the Term of Assent. The study received approval from the Research Ethics Committees of Universidade Pitágoras Unopar Anhanguera de Londrina (protocol number: 33873520.9.2002.0108) and Universidade de Nove de Julho (protocol number: 33873520.9.0000.5511).

The inclusion criteria for the study were adolescents aged 12 to 18 years, native Brazilians, accompanied by a parent or guardian at the consultation, with a clinical diagnosis of asthma made by a pulmonologist based on the Global Initiative for Asthma (GINA) guidelines. The exclusion criteria included participants or families wishing to withdraw from the study, adolescents with chronic conditions (neurological or mental) that impaired their ability to understand the questionnaires, and those with other chronic respiratory diseases (bronchiolitis obliterans, cystic fibrosis, and allergic rhinitis).

The general data collected included age, weight, height, personal history, and self- or parent-reported comorbidities to characterize the sample. Lung function was evaluated using spirometry following international guidelines.[16] Participants performed both pre- and post-bronchodilator maneuvers. The recorded variables were forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), and the FEV_1/FVC ratio, which are key measures in assessing pulmonary function.

For the classification of asthma control levels and severity, the GINA criteria were adopted. Based on responses to four questions regarding the last four weeks: (a) presence of daytime symptoms more than twice a week, (b) nighttime symptoms, (c) use of reliever medication more than twice a week, and (d) activity limitations; disease control was categorized as follows: (1) Controlled: None of the questions received a positive answer; (2) Partially controlled: One or two questions received a positive answer; (3) Uncontrolled: Three or four questions received a positive answer.

Asthma severity was classified into three levels: (1) Mild: well-controlled with reliever medication or low-dose inhaled corticosteroids, anti-leukotrienes, or chromones; (2) Moderate: well-controlled with low-dose inhaled corticosteroids combined with long-acting bronchodilators; (3) Severe: requiring high-dose inhaled corticosteroids and long-acting bronchodilators to remain controlled, or remaining uncontrolled despite such treatment.

Motivational regulation for physical exercise was evaluated using the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2), which measures amotivation as well as intrinsic and extrinsic motivation. The instrument consists of 19 Likert-type items with five response options (0 = "Not true for me" to 4 = "Very true for me"). These items comprise five different motivational loci: amotivation, external regulation, introjected regulation, identified regulation, and intrinsic regulation. In the controlled forms of regulations (amotivation, external regulation, and introjected regulation), lower scores reflect less behavioral control. In autonomous forms of regulations (identified and intrinsic regulation), higher scores indicate greater autonomy in exercise behavior. Each motivational regulation is scored from 0 to 4, with higher values indicating greater endorsement of that regulation as a reason to exercise. The Self-Determination Index (SDI) was also calculated, ranging from -24 (lowest self-determination) to 20 (highest self-determination). This version of the questionnaire has been validated for use with Brazilian adolescents.[17,18]

The Basic Psychological Needs in Exercise Scale (BPNES) was used to assess participants' perceptions of support for basic psychological needs in exercise. The scale contains 12 items, divided into three subscales representing the psychological needs: Autonomy, Competence, and Relatedness. Responses ranged from 1 ("Disagree") to 5 ("Strongly agree").[17] Higher scores indicate greater perceived support for each psychological need. This instrument has also been validated for use with Brazilian adolescents.[19]

To evaluate quality of life, the Pediatric Quality of Life Inventory (Peds-QL) was used. This instrument combines both generic and disease-specific scales. The validated Brazilian Portuguese version[20] consists of 23 items, distributed across four domains: Physical function, Emotional function, Social function, and School function. A psychosocial domain score is derived by summing the emotional, social, and school function scores. Each item uses a five-point Likert scale (0 = "Never" to 4 = "Almost always"), which is subsequently transformed into a linear scale from 0 to 100, with higher scores reflecting better health status. The assessment period covers experiences from the from month.[20]

Statistical analysis was conducted using SPSS® (version 22.0). Categorical variables were expressed as absolute and relative frequencies (%), and numerical data were reported as mean (μ) and standard

deviation (SD) or median and interquartile range (IQR), depending on normality distribution as assessed by the Shapiro-Wilk test. A two-step cluster analysis was performed using two models: (1) a Motivational Regulations Model, which included amotivation, external regulation, introjected regulation, identified regulation, and intrinsic regulation scores; and (2) a Basic Psychological Needs Model - which included autonomy, competence, and relatedness scores. The optimal number of clusters was determined based on the best combination of low Bayesian Information Criterion (BIC), high ratio of distance measures, and high ratio of BIC changes, as well as meaningful conceptual considerations. The silhouette coefficient (ranging from -1 to +1) was used to assess the quality of the cluster solution, with higher values indicating better cohesion within clusters and separation between them. Clusters were compared using the independent Student T-test, Mann-Whitney test, or Chi-Square test, as appropriate. Statistical significance was set at $p < 0.05$.

Results

A total of 160 participants were assessed for eligibility. Of these, 10 were excluded due to incomplete questionnaire responses, 4 had chronic disease with cognitive impairment, and 2 presented with other associated lung diseases (Figure 1). The final sample comprised 144 participants, with 80 recruited from São Paulo and 64 from Londrina. Most participants were male, exhibited mild airway obstruction, and had controlled asthma. Table 1 provides an overview of the participants' general characteristics, along with their Motivational Regulation and Basic Psychological Needs profiles. Overall, adolescents demonstrated more autonomous reasons for exercising and moderately recognized the support of basic psychological needs in their practice. Comparative analyses between adolescents from the two research centers are presented in Supplementary Table S1.

Cluster identification and model quality

All participants were eligible for cluster analysis, as described in Supplementary Table S2. The clusters were labeled based on the theoretical framework of SDT. Cluster 1 displayed high levels of autonomous regulation, lower levels of controlled regulation, and perceived stronger support for basic psychological needs. This cluster was labeled as the 'More autonomous behavior and high perceived support' cluster. Cluster 2 exhibited low levels of autonomous regulation, high levels of controlled regulation, and reported less support for their basic psychological needs. This cluster was named the 'Less autonomous behavior and low perceived support' cluster. Table 2 presents the characteristics and differences between the two clusters. The silhouette coefficient for the model was 0.40, suggesting a fair-quality solution. Among the predictor components, relatedness showed the highest relative importance (1.00) in estimating both the BPN and MR models.

Clusters by motivational profile and basic psychological needs

Cluster 1, 'More autonomous behavior and high perceived support'

This cluster consisted of 56 participants (38.9%), predominantly males with a normal BMI. These adolescents demonstrated a higher self-determination index, higher autonomous regulation, and greater

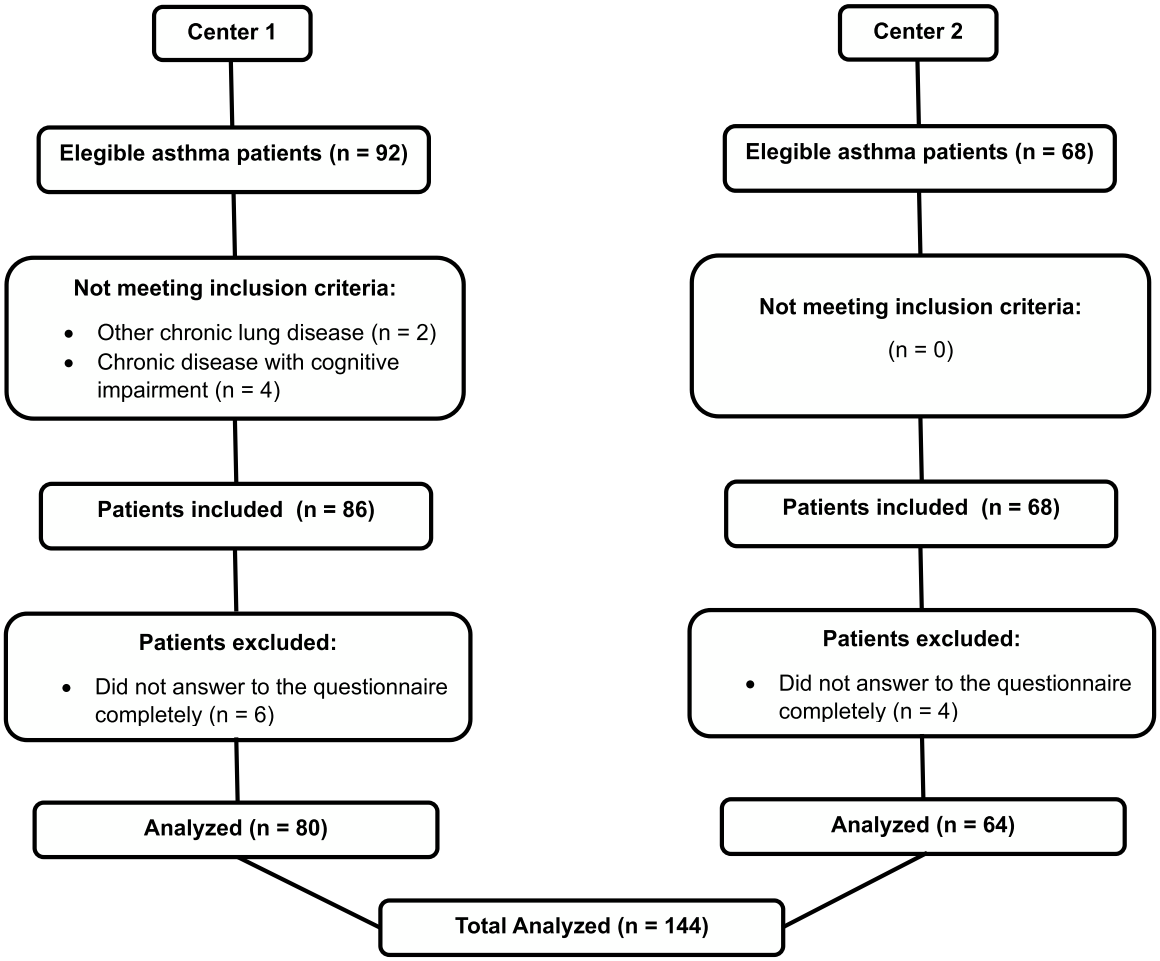

Figure 1. Flowchart of the study.

Table 1
Participant characteristics.

Sociodemographic, anthropometric and clinical data	All Participants (n=144)
São Paulo/Londrina	80/64 (55% / 45%)
Boys/ Girls, n	76/68 (53% / 47%)
Age, yrs	14 (2)
BMI, kg/m^2	22.60 (6.20)
Diagnostic time, yrs	8.70 (4.02)
Asthma control	
Controlled asthma, n (%)	93 (65%)
Partially controlled asthma, n (%)	38 (26%)
Uncontrolled asthma, n (%)	13 (9%)
Asthma gravity	
Mild, n (%)	65 (45%)
Moderate, n (%)	55 (38%)
Severe, n (%)	24 (17%)
Pulmonary function	
$FEV_{1,}$ L	2.38 (0.66)
$FEV_{1,}$ %predicted	95 (16)
FVC, L	3.04 (0.81)
FVC, % predicted	102 (14)
FEV_1/FVC, %	95 (13)
Behavioral Regulation for Physical Exercise	
Behavioral Regulation in Exercise Questionnaire-2, BREQ-2	
Amotivation, units	0.73 (0.89)
External regulation, units	0.81 (1.08)
Introjected regulation, units	0.84 (1.00)
Identified regulation, units	2.20 (1.00)
Intrinsic motivation, units	2.57 (1.22)
Self-determination index, units	7.13 (7.88)
Basic psychological needs	
Basic Psychological Needs in Exercise Scale, BPNES	
Autonomy, units	3.25 (1.09)
Competence, units	3.40 (1.10)
Relatedness, units	3.25 (1.19)
Quality of life	
Peds-QL, total score	76.0 (15.7)
Physical, score	80.7 (16.0)
Emotional, score	78.5 (15.7)
Social, score	80.7 (15.4)
School function, score	82.2 (15.0)
Psychosocial, score	79.2 (14.0)

Data are expressed as mean (standard deviation); n: number of participants; % percentage; FEV_1: Forced expiratory volume in first second; FVC: Forced vital capacity; Peds-QL: *Pediatric Quality of life Inventory*.

fulfillment of BPN in the practice of physical exercises. Additionally, 67% of participants had controlled asthma, with 42% reporting mild and 43% reporting moderate symptoms.

Cluster 2, 'Less autonomous behavior and low perceived support'

This cluster consisted of 88 participants (61.9%), predominantly female with normal BMI. These adolescents exhibited lower levels of self-determination, less autonomous regulation compared with Cluster 1, and lower perceived support for BPN related to physical exercise. Most participants (63%) had controlled asthma, with symptoms predominantly mild (47%) or moderate (35%).

Comparisons between clusters

Cluster 1 demonstrated significantly better quality of life compared to Cluster 2 [71 (SD: 15) vs 83 (SD:15) points, respectively P<0.0001]. Cluster 2 had a higher proportion of females [50 (57%) vs 18 (32%); P=0.006]. No significant differences were observed in asthma control or disease severity (p>0.05). Detailed cluster comparisons are presented in Table 2.

Discussion

This study characterized the motivational profiles for physical exercise in adolescents with asthma and applied hierarchical cluster analysis to characterize distinct clinical outcomes based on Motivational Regulation and Basic Psychological Needs. These constructs were evaluated within the framework of Self-Determination Theory.[8,9] Two distinct groups emerged, differentiated by their motivational profile related to physical exercise and quality of life. Our findings align with the principles of SDT,[8,9] indicating that individuals who engage in PA with more autonomous - or self-determined - motivation tend to experience greater mental health and well-being, while those driven by controlled motivations or less self-determined reasons, derive fewer benefits.[8,9,21]

Based on their motivational profile and supported by previous findings, we can infer that the adolescents in cluster 1 ('More autonomous behavior and high perceived support') would likely engage in physical exercise more frequently, with greater ease, and more positive affective outcomes.[22] Previous systematic reviews indicate higher levels of physical activity when adolescents experience more autonomous forms of motivation toward PA[23] and perceive strong social support from friends and family.[24] Additionally, in adolescents with asthma, feelings of belonging, fitting in, and being valued as part of the intervention,[14] as well as engaging in PA that is enjoyable and fun,[14,25] have been shown to increase the PA levels.

Cluster 2, labeled 'Less Autonomous Behavior and Low Perceived

Table 2
Cluster characteristics of participants identified according to motivational regulations and basic psychological needs.

Motivational Regulations and Basic Psychological Needs model	Cluster 1 More autonomous behavior and high perceived support (n=56)	Cluster 2 Less autonomous behavior and low perceived support (n=88)
Boys/ Girls, n (%)	38/18 (67% / 53%)	38/50 (43% / 57%) #
Age, yrs	14 (2)	14 (2)
BMI, kg/m^2	22.3 (5.8)	22.9 (6.4)
Diagnostic time, yrs	9.0 (4.2)	8.4 (3.9)
Asthma control		
Controlled asthma, n (%)	37 (67%)	56 (63%)
Partially controlled asthma, n (%)	16 (28%)	22 (25%)
Uncontrolled asthma, n (%)	3 (5%)	10 (12%)
Asthma gravity		
Mild, n (%)	23 (42%)	41 (47%)
Moderate, n (%)	24 (43%)	31 (35%)
Severe, n (%)	9 (15%)	16 (18%)
Pulmonary function		
FEV_1, L	2.56 (0.62)	2.28 (0.68)
$FEV_{1,}$ % predicted	98 (16)	93 (15)
FVC, L	3.27 (0.88)	2.91 (0.76)
FVC, % predicted	102 (15)	102 (13)
FEV_1/FVC, %	81 (12)	75 (19)
Behavioral Regulation for Physical Exercise		
Amotivation, units	0.62 (0.83)	0.86 (0.93)
External regulation, units	0.76 (1.07)	1.00 (1.08)#
Introjected regulation, units	0.99 (1.08)	0.75 (0.93)
Identified regulation, units	2.79 (0.76)	1.82 (0.96)#
Intrinsic regulation, units	3.44 (0.70)	2.01 (1.15)#
Self-determination index, units	11.5 (6.24)	4.34 (7.56)#
Basic psychological needs		
Autonomy, units	3.96 (0.71)	2.68 (0.88)#
Competence, units	4.49 (0.51)	2.82 (0.91)#
Relatedness, units	4.41 (0.55)	2.51 (0.84)#
Quality of life		
Peds-QL, total score	83.0 (14.6)	71.5 (15.2)#
Physical, score	82.7 (14.7)	79.4 (16.6)
Emotional, score	77.2 (14.7)	79.3 (16.4)
Social, score	80.6 (14.2)	80.7 (16.1)
School Function, score	80.0 (15.9)	83.7 (14.3)
Psychosocial, score	79.5 (12.5)	79.1 (15.0)

Data are expressed as mean ± standard deviation or n (%). BMI: body mass index; FEV_1: forced expiratory volume in 1 s; FVC: forced vital capacity; Peds-QL: *Pediatric Quality of life Inventory*. #P<0.05 versus cluster 1.

Support', is associated with a worse quality of life in adolescents with asthma. Adolescents in this group exhibited motivational profiles characterized by less recognition of self-determined motivations and more recognition of controlled reasons to exercise compared to Cluster 1. Their motivation may be more often driven by guilt, rewards, pressure, or fear, with fewer feelings of joy or pleasure. Adolescents with asthma frequently report challenges in managing their lives compared to healthy peers[26] and feel embarrassed by their symptoms or medications and different from their peers,[14] which could affect their sense of autonomy, competence, and relatedness.[8,9] Furthermore, these adolescents may face physical activity and exercise as 'medicine' rather than 'fun', which is not the best approach for achieving long-term, sustainable behavior change.[27,28] Research suggests that promoting physical activity and exercise as a fun and integral part of daily life is more effective, because health-driven motives alone are unlikely to sustain long-term participation.[27] This approach may be particularly beneficial for adolescents in Cluster 2. From a behavioral perspective, their motivational profile presents an additional challenge promote exercise-related behavior change

Notably, females were more likely to fall into Cluster 2. This aligns with previous findings showing that girls tend to display lower levels of self-determined motivation during adolescence.[29,30] Additionally, females not only exhibit a less favorable motivational profile for PA but also have higher rates of inactivity, compared to males, both in the general population[31] or in adolescents with respiratory diseases such as asthma and cystic fibrosis.[27] These patterns suggest that promoting PA may require gender-specific approaches. Effective strategies should consider the unique relationship between self and social identity and PA across genders, as well as the distinct motivational factors driving participation in sports and exercise.[29]

Physical inactivity and sedentary behavior are common in individuals with asthma[32] and are significantly associated with poor clinical outcomes and lower health status.[33] Participation in physical activity among children and young people with asthma is shaped by three interconnected factors: their own beliefs about the illness, parental and family attitudes, and the knowledge, attitudes, and organizational practices within schools. Addressing this requires a multifaceted approach that must also consider social and family contexts, align with personal goals and values, and directly address the misinterpretation of symptoms to promote sustained participation in physical activity.[34] Evidence from the general population and other chronic diseases suggests that these behaviors are modifiable.[35,36] Understanding these behavioral characteristics in individuals with asthma is essential for developing interventions that go beyond current asthma management.

Understanding the psychological mechanisms behind physical activity behavior is essential for developing effective interventions for adolescents with asthma. For these adolescents to internalize motivation, they need to perceive that their social environments support and allow them to act autonomously. Consequently, those with autonomous motivation toward physical activity tend to experience better psychological well-being, driven by the sense of fulfilling the BPNs, regardless of their actual level of participation in the behavior.[21] Focusing on autonomous motivation in interventions can be an effective strategy to promote physical activity among children and adolescents. For those already involved in physical activity, fostering autonomy-supportive environments can enhance their health outcomes. Meanwhile, interest and enjoyment - key elements of SDT - are essential for motivating inactive individuals to become active. Enjoyment, as a positive emotional experience, offers immediate rewards and encourages spontaneous participation without external incentives.[37]

Healthcare professionals often rely on controlled motivation by offering incentives for physical activity or invoking guilt when it is not pursued. While these strategies can temporarily boost physical activity, they rarely lead to long-term behavior changes. Additionally, healthcare providers often prioritize clinical outcomes, such as improving lung function, which may not always align with the primary goals of patients.[27] Health professionals should be better prepared to create an environment that is more conducive to facilitating behavior change related to PA.[28]

Despite the differences observed in health-related quality of life between clusters, no differences were found in asthma control and disease severity. This may be attributed to the cross-sectional design of the study in addition to the multifactorial characteristics of disease control and severity in children with asthma.[38,39] We hypothesize that future longitudinal and prospective studies regarding exercise behavior in adolescents with asthma can better control external factors and perhaps identify associations between these outcomes.

Our study has several strengths and limitations. Behavior change strategies have been recommended for managing asthma.[40,41] However, this is the first study that sought to classify adolescents with asthma based on exercise behavioral characteristics. Another strength is the inclusion of participants from two cities, enhancing the external validity of the findings. However, there are notable limitations. One limitation of this study is the absence of any measures—objective or subjective—of physical activity. This shortcoming, along with the lack of a control group, restricts our ability to fully explore and interpret the influence of these factors on the outcomes. Future research should incorporate comprehensive assessments of physical activity and lifestyle behaviors to provide a more robust understanding of their impacts. Despite this, the findings align strongly with the tenets of SDT[8,9] and are consistent with SDT's evidence. In addition, the cross-sectional nature of the study prevents causal conclusions. Further studies are needed to more deeply understand the impact of different motivational profiles related to exercise in this population and to investigate how to develop interventions that incorporate physical exercise with behavior change techniques to foster autonomous motivation, promoting positive and sustainable behavioral changes in adolescents with asthma when participating in PA in rehabilitation settings.

Conclusion

This study is the first, to our knowledge, to explore and classify the behavioral characteristics of adolescents with asthma based on their motivational regulations and basic psychological needs for physical exercise. We identified two different motivational profiles related to physical exercise among adolescents with asthma, suggesting that, from a motivational/behavioral perspective, that some adolescents with asthma may experience additional difficulties in exercising. Furthermore, clustering based on the behavioral characteristics of motivational regulations and basic psychological needs has been associated with quality of life, a key clinical outcome in asthma.

Our findings provide novel insights into the management of adolescents with asthma, highlighting the importance of assessing exercise motivation in clinical practice. This approach can facilitate individualized, multidimensional assessments to support the development of patient-tailored interventions, thereby improving disease management and increasing the likelihood of more favorable treatment outcomes. Understanding these motivational profiles can help healthcare professionals identify adolescents who may encounter greater challenges and barriers to exercise. Such individuals would benefit most from targeted behavior change strategies using appropriate techniques.

Declaration of competing interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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Supplementary materials

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