


Acceptability of Exercise in Urban Emergency Department Patients With Metabolic Syndrome, Including a Subset With Venous Thromboembolism

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Lauren K Stewart, MD, MS¹  and Jeffrey A Kline, MD²

Abstract

Metabolic syndrome (MetS) afflicts more than one-third of US adults. In venous thromboembolism (VTE), MetS increases the risk of recurrence and severity of the post-pulmonary embolism syndrome, disproportionately affecting persons of color in urban settings. Exercise can positively modulate components of MetS. Our objective was to survey a sample of urban emergency department (ED) patients with MetS on their exercise habits and interest in increasing activity levels and to compare \pm VTE patients. This survey study consisted of: (1) International Physical Activity Questionnaire, and (2) Likert scale gauging interest in increasing activity levels. Any adult ED patient with a composite MetS profile was included. We surveyed 247 patients with an average age of 59 years and 57% reported Black race. Only 9% met recommendations for vigorous exercise and 28% for moderate activity, with no significant difference in the 18% with prior VTE. Fifty-seven percent responded positively regarding motivation in increasing activity. This survey presents novel data supporting the need and feasibility of an interventional study examining exercise as an adjuvant therapy in patients with MetS and VTE.

Keywords

metabolic syndrome, venous thromboembolism, physical activity, obesity

Introduction

Metabolic syndrome (MetS) is generally defined by the presence of 2 or more of the following: abdominal obesity, impaired glucose metabolism, hypertension, and dyslipidemia (1). MetS continues to increase in prevalence worldwide, increasing in parallel with rising obesity trends (2). In the United States, the national prevalence among adults was most recently estimated to be 37%, based on National Health and Nutrition Examination Survey data (3). The condition particularly affects minority persons living in urban settings (4,5). MetS confers numerous adverse health consequences, perhaps most notably an approximately 2-fold increase in the risk of cardiovascular disease over the 5 to 10 years following diagnosis (6). Other important health considerations include a 5-fold increase in the development of type 2 diabetes mellitus, as well as increased risk of cancer, polycystic ovarian syndrome, and fatty liver disease (7–9).

Specific to venous thromboembolism (VTE), which includes both pulmonary embolism (PE) and deep vein thrombosis, MetS has been previously demonstrated to increase the risk of VTE

incidence and recurrence as well as worsen the severity of the post-PE syndrome, which comprises a spectrum of physical and psychosocial manifestations that include dyspnea, exercise intolerance, deconditioning, fatigue, anxiety, and rumination about fear of recurrence (10–12). Although the mechanism of these adverse effects is not yet fully elucidated, MetS is associated with a dysregulated secretion of adipokines from excess adipose tissue, which can produce low-grade systemic inflammation, endothelial dysfunction, vascular remodeling, and eventually, thrombosis (13).

Several pharmacological therapies exist to target the individual components of MetS, including antihypertensives,

¹ Department of Emergency Medicine, Indiana University School of Medicine, Indianapolis, IN, USA

² Department of Emergency Medicine, Wayne State University, Detroit, MI, USA

Corresponding Author:

Lauren K Stewart, Department of Emergency Medicine, Indiana University School of Medicine, Indianapolis, IN, 46202, USA.
Email: laustewa@iupui.edu



antiglycemic medications, and statins (14). However, in addition to these medications, daily exercise has the potential to positively modulate all components of MetS (15). Important to VTE, exercise reduces plasma fibrinogen and increases fibrinolytic capacity, thus affording a strong antithrombotic effect (16,17). Additionally, exercise decreases circulating inflammatory agents, reduces platelet activity, reduces venous stasis, and enhances vascular endothelial regulation of arterial tone (18–21). Given these potential benefits, it has been postulated that exercise could play an important role as an adjunctive therapy in newly diagnosed VTE, especially in patients with comorbid MetS risk factors (22,23). However, adherence and effectiveness of exercise in patients with VTE remain understudied, and adherence factors such as age, employment status, and attitudes toward exercise may be distinct for this population (24,25). Compared with patients enrolled in cardiac rehabilitation programs, patients with VTE tend to be younger and more often employed. These factors have both been reported to be associated with relatively increased participation in physical activity among the US population, although still generally underutilized (26,27). However, patients suffering from PE may also develop increased psychological stress, including clot recurrence fears that hinder exercise readiness (28).

In considering exercise as a proposed intervention, the following 2 conditions should be addressed: (1) whether this is an underutilized resource in the population of interest, and (2) whether this is an intervention in which patients will be willing to participate. The US Department of Health and Human Services (HHS) 2018 Physical Activity Guidelines Advisory Committee recommends that healthy adults engage in moderate-intensity cardiopulmonary exercise training for at least 150 min per week, or vigorous-intensity aerobic activity for 75 min per week (29). However, existing data suggest modest involvement in exercise nationwide. A recent report from the Centers for Disease Control (CDC) found that only 23% of US adults actually met the recommendations laid out in these guidelines (30). The objective of this study was to survey a sample of emergency department (ED) patients with MetS on their current exercise habits, as well as their interest in implementing an exercise-based lifestyle change, and to compare results in patients with and without prior VTE. We hypothesized that exercise would be an underutilized resource in this population of MetS patients.

Methods

Overall Study Design

This was a survey-based study of adult patients with a composite MetS profile presenting to a single-center, urban ED. Data collection began in January 2020 and continued through May 2021. Inclusion in this study required a composite MetS profile, which was defined as the presence of at least 3 of the following: (1) hypertension (an *ICD-10* diagnosis of hypertension (I10) or a documented prescription for

antihypertensive medication), (2) dyslipidemia (*ICD-10* diagnosis of hyperlipidemia (E78) or prescription for an anti-lipid medication), (3) impaired glucose metabolism (*ICD-10*-diagnosis of diabetes mellitus type II (E11) or prescription for an antidiabetic medication), (4) obesity (*ICD-10* diagnosis of obesity (E66) or body mass index [BMI] over 30 kg/m²). Exclusion criteria consisted of any condition that would limit the patient's ability to participate including critical medical illness, acute intoxication, or psychotic state. Children were also excluded. Eligible patients were identified by study associates through real-time surveillance of the electronic health record (EHR) in the ED.

Eligible patients were approached and asked to complete a 2-part survey regarding current exercise habits. The first portion of this survey consisted of a common, validated approach to measuring physical activity, The International Physical Activity Questionnaire (IPAQ)-Short Form (31). This 7-item questionnaire assesses the types of the intensity of physical activity and sitting time that participants do as part of their daily lives, as estimated through the last 7-day recall. The specific types of activity assessed include walking, moderate-intensity activities, and vigorous-intensity activities, with both frequency (days per week) and duration (time per day) collected for each activity type. The IPAQ questionnaire, as well as details of its scoring protocol, can be accessed as follows: <https://sites.google.com/site/theipaq/>. The second portion of the administered survey included the following question and Likert scale-based response options: "How interested are you in increasing the amount of time you spend exercising or engaging in physical activity?" (very interested, somewhat interested, neutral, somewhat uninterested, very uninterested). A final, open-ended question asked patients to describe any perceived barriers to exercise. This was developed using an iterative process to ensure clarity of content.

We also obtained pertinent demographic and comorbidity data through a direct patient query, which included the presence or absence of several medical comorbidities (including the components of MetS), the use of home oxygen, medical insurance status, disability status, and smoking status. The EHR was accessed only in the initial screening process to determine patient eligibility, and no personal health information was recorded. The study protocol was reviewed by the Institutional Review Board (IRB) and determined to be exempt. All procedures in this study were conducted in accordance with the Indiana University IRB's approved protocols. All participants received a study information sheet explaining pertinent details of study participation and provided verbal consent. Those administering the survey were individually trained by the PI and personally observed during initial encounters to ensure consistency across associates. Data were collected in REDCap®.

Statistical Analysis

Statistical analysis was performed using SAS software (version 9.4). We first measured the times spent in each

type of physical activity intensity and analyzed results using descriptive statistics. We recorded which participants met current national guidelines for physical activity based on HHS recommendations and then separated participants into 2 groups based on whether or not these recommendations were met. We compared means of continuous variables between the 2 independent groups utilizing the Student t test, assuming an approximate normal distribution. Pearson χ^2 was used to investigate the association of categorical variables, including baseline demographics and comorbidities, with the binary outcome of \pm meeting physical activity recommendations. In a further subgroup analysis, we identified patients with a prior history of VTE and compared this group's current exercise habits and interest in increasing levels of activity to patients without a history of VTE. Based on sample size calculation, our sample of $N = 247$ participants provides a margin of error of 5% at an α of .1 for survey responses.

Results

We screened a total of 2344 patients upon arrival to the ED, of which 1957 (83%) were determined to be ineligible. The vast majority (96%) were ineligible as they did not meet specific criteria for MetS diagnosis. Of the 387 eligible patients, 247 (64%) enrolled in the study and completed the survey. The remaining eligible patients were either missed ($n = 53$) or declined enrollment ($n = 87$), with common reasons including that they were either not feeling well or not interested in research. This is represented visually in Figure 1.

Pertinent demographic and comorbidity data for all survey participants are included in Table 1. This was a relatively diverse cohort of participants. Hypertension was the most common comorbid component of MetS in patients, with a prevalence of 96%. The average BMI across all survey participants was 36 kg/m², which falls within the class 2

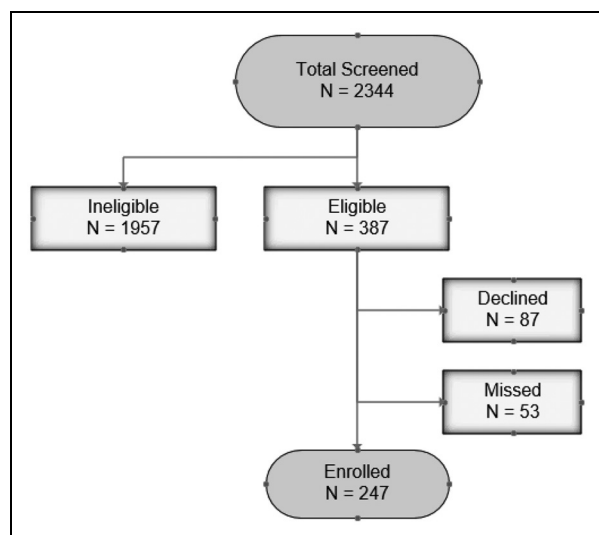


Figure 1. Patient screening and study enrollment.

category of obesity based on CDC classification. Eighteen percent of patients had prior history of VTE. Among other non-MetS comorbidities, depression was most common, reported in 43% of patients. Further, 56% of participants reported some degree of disability, while 15% reported use of home oxygen, both of which may be important considerations when addressing physical activity.

Table 2 displays data on the current exercise habits of survey participants. A total of 36 patients (15%) reported engaging in any amount of vigorous exercise during an average 7-day period, with only 22 (9%) meeting guideline recommendations for 75 min per week of vigorous-intensity aerobic activity. One-hundred and twenty-five patients (51%) reported engaging in any moderate-intensity cardiopulmonary exercise training during an average week, with 68 (28%) meeting recommendations for at least 150 weekly minutes. Seventy-four percent of participants ($n = 183$) walked for at least 10 min at a time during the prior 7 days, and participants spent an average of 8 h per day sitting. Table 2 also includes a comparison of exercise habits of a subgroup of patients with prior VTE history ($n = 45$) compared to those patients without VTE history ($n = 202$). There were no significant differences in the current exercise habits of patients based on prior VTE history.

Results from the survey question "How interested are you in increasing the amount of time you spend exercising or engaging in physical activity?" are displayed graphically in Figure 2. Overall, the majority (57%) of those surveyed responded positively, compared to 26% with a negative response. Seventeen percent ($n = 43$) of participants reported a neutral response. Figure 2 also compares results based on the presence or absence of prior VTE history. Patients with prior VTE responded similarly regarding their interest in increasing their level of physical activity.

Participants were also separated into 2 groups based on whether or not they currently met national guideline recommendations for weekly moderate physical activity, and groups were compared with the Student t test and Pearson χ^2 . There were no significant differences in demographic features, frequency of disability, use of home oxygen, smoking, or comorbid conditions between those participants meeting guidelines versus those not meeting guidelines (Table 1). Interestingly, those already meeting guideline recommendations for moderate activity were significantly more likely to respond positively regarding interest in increasing levels of activity (68% vs 53%, $P = .03$), while those not meeting guidelines were more likely to respond negatively (30% vs 13%, $P = .01$).

An open-ended question asked patients to identify and describe any perceived barriers to physical activity. Forty-two percent of patients ($n = 103$) provided a response to this question. Supplemental Table 1 displays a sample of representative patient responses. The majority of responding patients identified pain and/or physical restrictions and

Table 1. Demographics and Baseline Comorbidities, Including Total Cohort and Comparison of Participants ± Meeting Current Guideline Recommendations for Physical Activity.

	Total cohort (n = 247)	Meeting guidelines (n = 68)	Not meeting guidelines (n = 179)	P
Mean age in years	59.1	60.1	58.8	.42
Female (%)	130 (53)	37 (54)	93 (52)	.73
Hispanic or Latino (%)	22 (9)	4 (6)	18 (10)	.30
African American or Black (%)	142 (57)	39 (57)	103 (58)	.98
Caucasian or White (%)	92 (37)	25 (37)	67 (37)	.92
Asian or Asian American (%)	1 (0.4)	0 (0)	1 (1)	1.00
Native Hawaiian or Pacific Islander (%)	1 (0.4)	0 (0)	1 (1)	1.00
Other race (%)	10 (4)	4 (6)	6 (3)	.37
Hypertension (%)	236 (96)	66 (97)	170 (95)	.48
Hyperlipidemia (%)	201 (81)	59 (87)	142 (79)	.18
Diabetes mellitus (%)	190 (77)	53 (78)	137 (77)	.81
Average BMI in kg/m ²	36	37	36	.51
Chronic obstructive pulmonary disease (%)	76 (31)	24 (35)	52 (29)	.34
Congestive heart failure (%)	56 (23)	14 (21)	42 (24)	.63
Myocardial infarction (%)	50 (20)	19 (28)	31 (17)	.06
Cerebrovascular accident (%)	38 (15)	11 (16)	27 (15)	.83
Chronic kidney disease (%)	40 (16)	5 (7)	35 (20)	.02
Cancer (%)	37 (15)	12 (18)	25 (14)	.47
Atrial fibrillation (%)	41 (17)	10 (15)	31 (17)	.62
Anxiety (%)	94 (38)	25 (37)	69 (39)	.80
Depression (%)	107 (43)	30 (44)	77 (43)	.88
Prior venous thromboembolism (%)	45 (18)	12 (18)	33 (18)	.89
Disabled (%)	139 (56)	36 (53)	103 (58)	.52
Home oxygen use (%)	37 (15)	11 (16)	26 (15)	.75
Current smoker (%)	74 (30)	20 (29)	54 (30)	.91
Prior smoking history (%)	91 (37)	25 (37)	66 (37)	.99

Abbreviation: BMI, body mass index.

Table 2. Current Physical Activity Habits, Including Total Cohort and Comparison of Participants ± Prior Venous Thromboembolism (VTE) History.

	Total cohort (n = 247)	No VTE history (n = 202)	Prior VTE history (n = 45)	P
Performing any vigorous exercise during week (%)	36 (15)	29 (14)	7 (16)	.84
Meeting guidelines for vigorous exercise (%)	22 (9)	18 (9)	4 (9)	1.00
Performing any moderate exercise during week (%)	125 (51)	100 (50)	25 (56)	.46
Meeting guidelines for moderate exercise (%)	68 (28)	56 (28)	12 (27)	.89
Performing any walking activity during week (%)	183 (74)	153 (76)	30 (67)	.21
Average time spent sitting during waking hours	8 h	8 h	8 h	1.00

deconditioning due to underlying medical comorbidities as common barriers, including “I have trouble with my feet because of my diabetes” and “I get really out of breath just tying my shoes.”

Discussion

In this survey of urban, underserved ED patients with MetS, we found that few participants reported time and intensity of exercise that met national recommendations (9% for vigorous activity and 28% for moderate activity). However, the majority expressed a positive interest in participating in an exercise program. These findings align with prior reports describing a

high incidence of physical inactivity nationwide (30). Data from the CDC reported state and territory-level estimates of physical inactivity ranging from 17.3% to 47.7% (32). It has been previously well-established that physical inactivity leads to numerous unfavorable outcomes, including a higher burden of chronic disease, premature death, and increased healthcare costs (33,34). This is particularly true in the urban setting where MetS is a present and worsening public health problem, with increasing rates of obesity likely the driving force behind this observation (35). Urban residents are more likely to be obese than their suburban counterparts, as well as suffer from higher rates of obesity-related illness. Those living in urban settings are

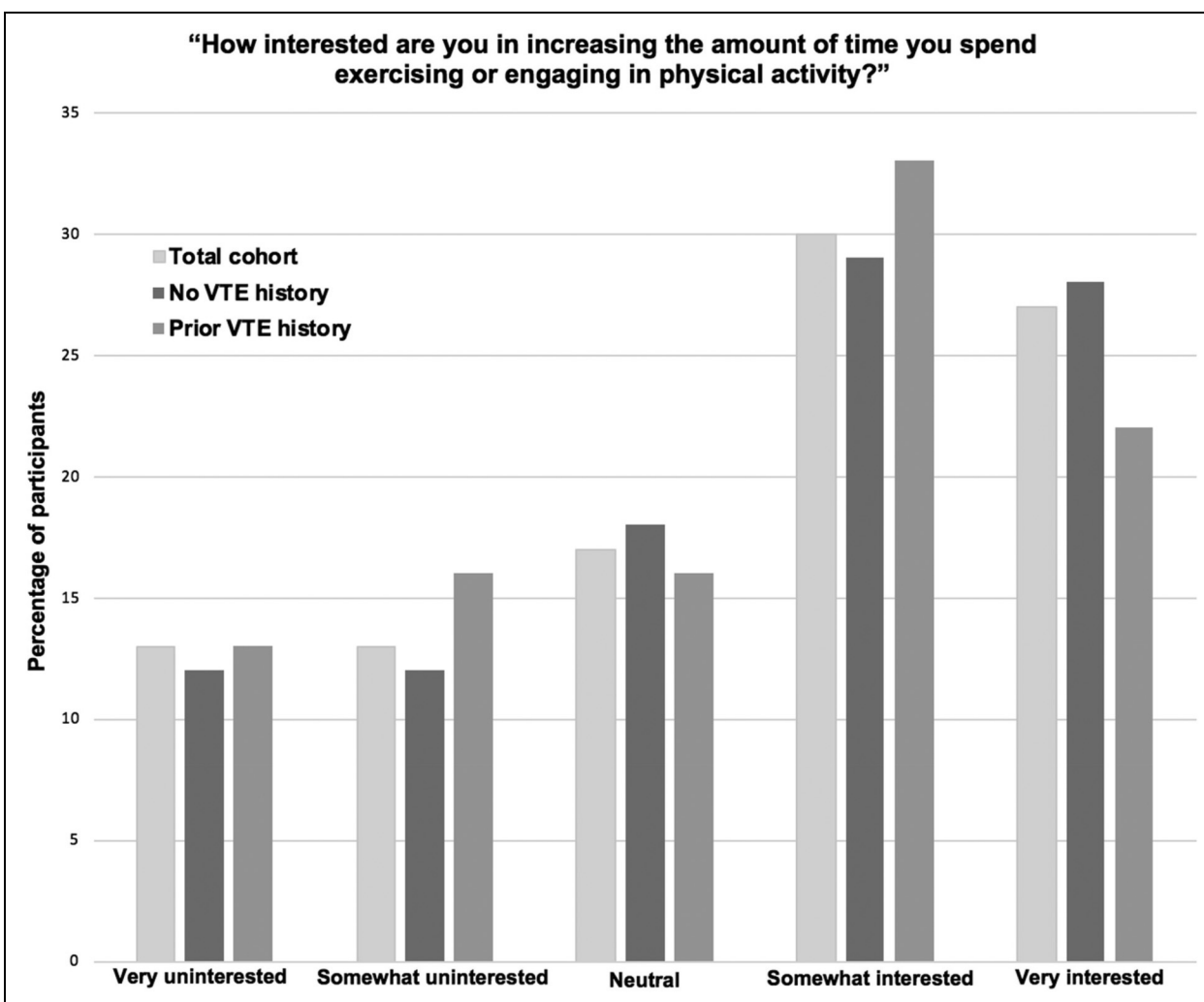


Figure 2. Patient interest in increasing levels of physical activity, including total cohort and comparison of participants \pm prior venous thromboembolism (VTE) history.

also less physically active as a whole, with a propensity for inactivity greatest among low-income subgroups (36,37). Levels of inactivity also differ considerably by race and ethnicity, with a higher prevalence of inactivity among non-Hispanic black adults and Hispanic adults compared to non-Hispanic white adults (32).

Although the accelerating incidence of MetS is of unquestionable concern, data from this survey support the potential to leverage the modifiable nature of MetS. Unlike age and many comorbid conditions, the components of MetS can generally be reversed or at least attenuated with an approach that may include a combination of dietary optimization, exercise, and pharmacologic therapy (14). Several dietary patterns have demonstrated benefit; however, no one of these approaches has been clearly established to be superior. Improvements more likely result from small and consistent dietary changes focused on healthy eating patterns rather than restriction of any single nutrient (38). Pharmacologic agents may also be employed in the treatment of MetS.

However, exercise may be the most comprehensive therapy available, as well as the most universally accessible, with the unique ability to positively modulate each of the individual components that comprise MetS (15,39,40). Additionally, relevant to the intersection of MetS and VTE, exercise affords a strong antithrombotic effect through the reduction of plasma fibrinogen and increased fibrinolytic capacity (16,17).

An overarching goal of future work, informed by the results of this study, is to increase the physical activity of patients with MetS who are diagnosed with VTE, and these findings lay the groundwork for a future interventional study examining exercise in this population. Compared with other cardiopulmonary disease states, exercise remains understudied in the VTE population (22,23). One recent study, and the first to our knowledge in acute PE, examined the effect of a physiotherapist-guided, 8-week home-based exercise program after PE. Results demonstrated that exercise was feasible and safe but did not lead to significant

differences in physical capacity and quality of life. However, the authors stated that they could not “make any conclusions regarding the optimal type, content, or frequency of a rehabilitation program” and suggested future study including those with an increased focus on patients with more severe PE and higher comorbidity burden (41). Given this lack of robust evidence, referral to rehabilitation or an exercise program is not currently standard of care in post-PE treatment. Notably, the recent 2019 European Society of Cardiology guidelines for the management of acute PE suggest that an efficient follow-up strategy should include “exercise rehabilitation, treatment of comorbidity, behavioral education, and modification of risk factors” (42). This recommendation was made on the basis of minimal, indirect, and low-quality evidence (23,41,43). Currently, no specific recommendations exist to help guide the implementation of such a program in post-VTE care.

Further, assuming exercise is beneficial in this population, there is also a lack of data concerning patient acceptability of an exercise program, as well as specific facilitators and barriers to exercise adherence in this population. This is important, as factors such as age, employment status, and attitudes toward exercise, may affect the adherence of patients with VTE to an exercise regimen. Compared with patients enrolled in cardiac rehabilitation programs, patients with VTE tend to be younger and more often employed, but they may have clot recurrence fears that hinder exercise readiness (24,25). Recent approaches to lifestyle interventions have begun to focus more directly on factors affecting patient adherence, specifically with the increasing availability of mobile health technologies and wearable devices that offer self-monitoring and an array of motivational features (44,45). The concept of gamification has also been employed in physical activity interventions, leveraging insights from behavioral economics to encourage increased participation (46). We hypothesize that exercise in the post-VTE period may have the greatest relative benefit in those with MetS, inasmuch as obesity and physical inactivity are likely to have been contributing factors in the initial VTE event and increase the risk of recurrence (10,11,47). Future studies examining the role of exercise as an adjuvant therapy post-VTE will likely benefit from close attention to facilitators and barriers to exercise that are unique to this population.

This study has several limitations. The study included a single center and relatively small sample size overall and had notable limitations in methodological design. We assessed physical activity utilizing the IPAQ-SF, as this is widely-used, resource-sparing and cost-effective (48). However, prior studies have demonstrated significant variability, with the majority suggesting that IPAQ-SF overestimates activity levels (49). This may imply an even larger unmet need than what we report here. Less than 20% of patients screened met our criteria for MetS, which is significantly lower than national estimates. This may indicate the presence of a biased sample, whereby our respondents were more likely to have had primary care (where they were

formally diagnosed with the MetS components), and therefore may represent a group intrinsically more interested in seeking and adhering to traditional medical care (including an exercise prescription) than persons with undiagnosed MetS. Finally, data collection was temporarily interrupted by the COVID-19 pandemic, and it is possible that the particular stage of the pandemic may have impacted how subjects responded. However, this was only specifically identified as a barrier by 2 of the 247 survey respondents.

Conclusion

This is the first ED survey of urban patients with a composite MetS profile to assess their degree of exercise and interest in participating in an exercise program. The results indicate that although the majority of these patients, including those with a prior history of VTE, do not currently meet national recommendations for the amount of weekly physical activity, they do express a desire to participate in an exercise program. These data support the need and patient willingness to participate in an implementation study of exercise as an adjuvant therapy in VTE.

Authors' Note

Ethical approval was obtained from the Indiana University Institutional Review Board and determined to be IRB Exempt. All procedures in this study were conducted in accordance with the Indiana University IRB's approved protocols. Verbal informed consent was obtained from the patients for their anonymized information to be published in this article.


Declaration of Conflicting Interests

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ORCID iD

Lauren K. Stewart  <https://orcid.org/0000-0002-1867-5917>

Supplemental Material

Supplemental material for this article is available online.

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