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RESEARCH

Muscle-strengthening activities: practices, barriers, and approaches for their promotion—results from an online survey

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Abstract

Background Muscle-strengthening activities (MSAs) like resistance training are a cornerstone of physical activity guidelines.
Aim To extend previous research on MSAs practices (beyond MSAs frequency) and barriers to MSAs.
Methods A convenience sample completed a cross-sectional online survey. The survey included a questionnaire that assessed whether participants engaged in MSAs, which type(s) of resistance they used (e.g., free weights, bodyweight), and whether they performed them according to the World Health Organization (WHO) guideline on ≥ 2 days/week, at moderate or greater intensity, and involving all major muscle groups. Participants who did not engage in MSAs were asked about barriers.
Results Valid data were available for 351 adults (mean age = 31.8 ± 14.9 years; 51.9% females), of which 242 (68.9%) reported engaging in MSAs, and 80 (22.8%) met the WHO guideline on MSAs. Bodyweight was the most-utilized type of resistance (77.7%), followed by free weights (62.4%), machines (61.6%), and resistance bands (19.4%). A lack of time and having no specific reason were the most-reported barriers (33.0% each), followed by a lack of enjoyment (26.6%). Sociodemographic factors associated with practices of and barriers to MSAs were identified.
Conclusions Fewer than one in four persons from a physically active sample met the WHO guideline on MSAs. Promoting resistance bands as an underutilized type of resistance might prove useful for increasing engagement in MSAs. Informing individuals about the health benefits of MSAs and providing time-efficient and enjoyable MSAs protocols appears important to address the most common barriers.

Keywords Physical activity · Muscle-strengthening activities · Resistance training · Guideline · Questionnaire · Survey

Abbreviations

BMI Body mass index
MSAs Muscle-strengthening activities
WHO World Health Organization

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Introduction

National and international public health authorities around the globe recommend performing muscle-strengthening activities (MSAs) [1–5]. The 2020 World Health Organization (WHO) guidelines recommend performing MSAs involving all major muscle groups on at least two days per week and at at least moderate intensity [1]. MSAs like resistance training provide a broad range of health benefits, including improvements in cardiometabolic health and a reduced risk of all-cause mortality [6–15].

Despite the important health benefits of MSAs, a recent meta-analysis reported that only around 23% of adults performed MSAs on at least two days/two times per week, as commonly recommended [16]. Importantly, even this relatively low number likely overestimates true adherence to the 2020 WHO MSAs guideline [1], since only MSAs frequency was considered – without accounting for the required intensity and specific muscle groups involved. Recent work indicated that not involving all major muscle groups in particular might be a relevant, but often-neglected obstacle to meeting the WHO MSAs guideline [17]. Taken together, promoting MSAs remains an important public health task, with great untapped potential for disease prevention and health promotion.

Yet, relatively little is known about the barriers that keep individuals from performing MSAs. Importantly, there might be barriers specific to MSAs beyond those commonly reported for general physical activity (e.g., a lack of time) [18, 19]. For instance, a 2017 review found that the perceived risk of certain health hazards (e.g., having a heart attack) and a fear of looking too muscular were barriers specific to performing resistance training among older adults [20]. Similarly, two other studies in women enrolled in college examined barriers to resistance training [21, 22]. Among other factors, both studies suggested that women-specific resistance training classes or areas may help overcome barriers in this population [21, 22]. Conversely, Shakespear-Druery et al. [23] found that believing one has sufficient skill and technique to safely perform MSAs was associated with higher odds of engaging in them at least twice a week, for example. These results suggest a complex interplay of factors influencing engagement in MSAs.

Building on these findings, another fundamental, yet largely unanswered question emerges: Which type(s) of equipment or resistance are regularly used by individuals participating in MSAs in everyday life (i.e., not in controlled intervention studies)? When considering resistance training as the primary form of MSAs, four main types of resistance are available: free weights (e.g., dumbbells, barbells), machines (e.g., leg press, lat pulldown), resistance/elastic bands, and one's bodyweight [e.g., pull-ups, push-ups] [11]. Insights into the extent to which these different types of resistance are employed could help to inform MSAs promotion interventions, for example, by choosing more popular equipment types or emphasizing that settings outside the gym can be used (e.g., when using bodyweight exercises or resistance bands).

Collectively, there are various open questions surrounding the MSAs practices of persons from diverse demographic backgrounds (e.g., regarding age, gender), as well as barriers to performing MSAs in the first place. Thus, the present study aimed to answer the following research questions:

1) Among persons who regularly perform MSAs, how can their MSAs practices be characterized in terms of frequency, intensity, involved muscle groups, and utilized type(s) of resistance?
2) Among persons who do not regularly engage in MSAs, what are the reasons for doing so (i.e., barriers to MSAs)?

Methods

We used the Checklist for Reporting of Survey Studies (CROSS) [24] to guide the reporting in the present article.

Study description

The present investigation was part of a cross-sectional, web-based survey. In the following, we only report methods and results that are relevant to the present investigation.

Recruitment of a convenience sample was spearheaded by members of a German University of Applied Sciences, whereby online (e.g., on social media) and offline (e.g., in fitness centers) advertisements were used. This recruitment strategy was not aimed at generating a representative sample allowing for generalizable conclusions. However, focusing primarily on contexts with greater proportions of already-active individuals enabled us to study any residual barriers to engaging in MSAs in these individuals and those who are regularly immersed in exercise-promoting environments. Participants had to be at least 18 years old. Ethical and legal considerations were addressed through self-assessment using the standardized process of the Joint Ethics Committee of the Bavarian Universities (GEHBa), which determined that full ethics approval was not required as the study did not involve patient data or related sensitive personal information. The study complied with the Declaration of Helsinki. All participants provided electronic informed consent at the beginning of the survey.

We used the online survey system LimeSurvey (www.limesurvey.org) to program and deliver the survey. The online survey was publicly accessible to all interested individuals between 18.06.2025 and 28.06.2025. Unique participant codes were derived for each participant, which enabled us to exclude participants in case of multiple participation. Data were stored in a GDPR-compliant manner on a server located in Germany.

Completing the survey took approximately 18 min. Questionnaires inquired about sociodemographic and anthropometric variables. In addition, participants were asked to complete questionnaires on their physical activity, exercise, and sports practices. The use of branching ensured the efficient delivery of the survey. A self-devised MSAs questionnaire was the core of the present investigation.

Muscle-strengthening activities questionnaire

The original version of the MSAs questionnaire used in the present study has been described in detail elsewhere [17]. In brief, the MSAs questionnaire combines questions from validated physical activity questionnaires into a short, pragmatic, preliminary tool for assessing adherence to the 2020 WHO guideline on MSAs [1]. The MSAs questionnaire starts with a filter question on MSAs engagement. Only if participants indicate that they routinely engage in MSAs, questions on the frequency (days/week), intensity (light, moderate, or vigorous intensity), and the involved muscle groups (legs, back, abs, chest, shoulders, arms) follow.

For the present investigation, the original MSAs questionnaire was slightly adapted (see the Appendix and [25] for more details). This also included the addition of two questions, which were presented depending on whether persons reported engaging in MSAs or not. Those who reported engaging in MSAs were further asked what type(s) of resistance they use to perform the MSAs: free weights, machines, resistance bands, and/or their bodyweight [11]. In contrast, those who reported not engaging in MSAs were asked if there were one or more specific reason(s) for not doing so. Informed by previous studies [18–23], we provided a selection of potential barriers to MSAs (e.g., a lack of time, fear of looking too muscular), but participants could also give free-text responses.

Figure 1 shows the flow of the MSAs questionnaire used in our study.

Statistical analysis

Descriptive statistics and proportions

Descriptive statistics were used to describe the characteristics of the sample and their MSAs practices (e.g., days/week of engaging in MSAs). When participants indicated engaging in MSAs less than once a week, this was counted as 0.5 days/week in our quantitative analyses of MSAs frequency. Additionally, we calculated proportions for the following events among the included participants: engaging in MSAs; MSAs on ≥ 2 days/week, as per the WHO guideline [1]; MSAs at moderate or greater intensity, as per the WHO guideline [1]; MSAs involving all major muscle groups, as per the WHO guideline [1]; meeting the complete WHO guideline on MSAs, i.e., frequency, intensity, involved muscle groups [1]; type(s) of resistance used (free weights, machines, resistance bands, bodyweight, and combinations thereof); reason(s) for not engaging in MSAs (health not good enough; fear of looking too muscular; lack of time; lack of knowledge; lack of equipment; lack of enjoyment; advised not to do MSAs; health concerns; no specific reason; prefer not to answer; other [= free-text response; free-text responses were classified as one of the other reasons, where possible]).

Associated factors

Using multivariate logistic regression, we explored differences in MSAs guideline adherence across age, gender (male, female), highest educational attainment (low [no school degree, lowest school degree], medium [intermediate secondary school degree,], or high [[subject-specific] higher education entrance qualification, university degree, doctorate]), and body mass index (BMI).

Multivariate logistic regression models using age, gender, highest educational attainment, and BMI as independent variables were further applied to examine the factors associated with the types of resistance used and the most common barriers to MSAs. We excluded one participant with a diverse gender and one participant without a valid response to the question on gender in the regression analyses to avoid having two additional small ($n = 1$ for each) gender groups.

We report odds ratios (ORs) and the corresponding 95% confidence intervals (CIs). Where indicated, the 95% CIs were used to evaluate statistical significance. We further report McFadden's pseudo R^2 for assessing model fit.

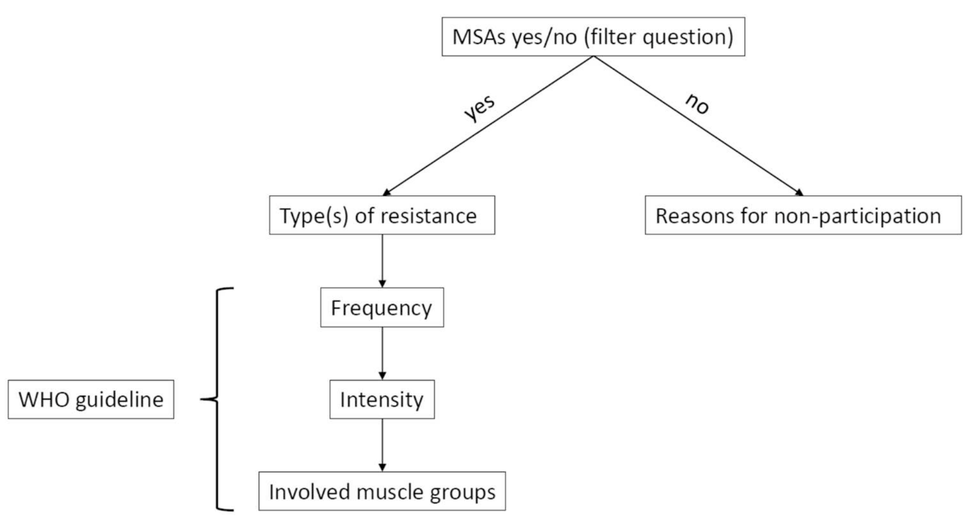

Fig. 1 Flow of the MSAs questionnaire Note. MSAs = muscle-strengthening activities; WHO = World Health Organization. See Brummer et al. [17], Brummer and Köllner [25], and the Appendix for further details on the MSAs questionnaire

Software

The statistical analyses were conducted in SPSS (version 30.0.0.0, IBM) and R [26], version 4.4.1, using RStudio (version 2024.04.2, Posit Software, PBC). Perplexity AI and ChatGPT were used to generate and double-check parts of the R code.

Results

The survey was started 530 times, of which 381 (71.9%) were complete runs. Of those, we excluded 23 test runs conducted prior to officially launching the survey, two runs with duplicate participant codes, and five underage participants. Thus, complete data from 351 participants were included in our analyses. Table 1 provides an overview of the characteristics of the included participants.

Guideline adherence

A total of 242 (68.9%) participants reported engaging in MSAs. Among these participants, MSAs frequency, intensity, and the number of involved muscle groups varied greatly, as summarized in Fig. 2. On average, participants who reported engaging in MSAs performed them on 2.4 (SD = 1.3) days per week, and 186 participants (53.0%) reported performing MSAs on ≥ 2 days/week, as per the WHO guideline.

Furthermore, 236 participants (67.2%) reported performing MSAs at moderate or greater intensity, as per the WHO guideline.

Moreover, participants who reported engaging in MSAs involved an average 4.5 (SD = 1.7) muscle groups, whereby 97 participants (27.6%) reported involving all major muscle groups in their MSAs, as per the WHO guideline.

Ultimately, a total of 80 participants (22.8%) met the complete WHO guideline on MSAs.

Table 1 Characteristics of and MSAs guideline adherence among included participants

		n (%)	$n_{adherent}$	$\%_{adherent}$
Total		351 (100)	80	22.8
Gender	Male	167 (47.6)	45	26.9
	Female	182 (51.9)	35	19.2
	Diverse	1 (0.3)	0	0.0
	No valid response	1 (0.3)	0	0.0
Age (years)[a]	18–29 years	228 (65.0)	61	26.8
	30–44 years	41 (11.7)	10	24.4
	45–64 years	74 (21.1)	9	12.2
	≥ 65 years	8 (2.3)	0	0.0
Highest educational attainment	No school degree	0 (0.0)	0	NA
	Lowest school degree	23 (6.6)	1	4.3
	Intermediate secondary school degree	82 (23.4)	15	18.3
	(Subject-specific) Higher education entrance qualification	146 (41.6)	34	23.3
	University degree	93 (26.5)	29	31.2
	Doctorate	7 (2.0)	1	14.3
BMI category[b]	Underweight	9 (2.6)	2	22.2
	Normalweight	219 (62.4)	60	27.4
	Overweight	90 (25.6)	18	20.0
	Obese	33 (9.4)	0	0.0

The Table shows the characteristics of the included participants, including their adherence to the WHO guideline on MSAs, i.e., performing MSAs on ≥ 2 days/week, at at least moderate intensity, and involving all major muscle groups [1]. Classification of highest educational attainments is based on the German system: No school degree = Kein Schulabschluss, Lowest school degree = Qualifizierender Hauptschulabschluss, Intermediate secondary school degree = Mittlere Reife, (Subject-specific) Higher education entrance qualification = (Fach-)Hochschulreife, University degree = Hochschulabschluss, Doctorate = Promotion. BMI cut-offs used: Underweight: BMI < 18.5, Normalweight: BMI ≥ 18.5 and < 25.0, Overweight: BMI ≥ 25.0 and < 30, Obese: BMI ≥ 30.0

Abbreviations: BMI = Body mass index; MSAs = Muscle-strengthening activities. NA = Not applicable

[a]When age was treated as a continuous variable: M = 31.8; SD = 14.9; Min = 18; Max = 81; Md = 24

[b]When BMI was treated as a continuous variable: M = 24.1; SD = 4.2; Min = 16.2; Max = 40.4; Md = 23.3

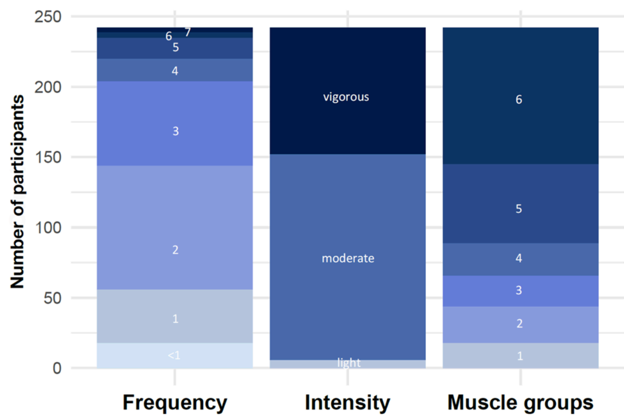

Fig. 2 Participants' MSAs frequency, intensity, and involved muscle groups practices Note. The frequency (days/week), intensity, and number of muscle groups involved in MSAs performed by participants engaging in MSAs ($n = 242$)

Types of resistance

Among those who performed MSAs, bodyweight was the most-utilized type of resistance (77.7%), followed by free weights (62.4%), machines (61.6%), and resistance bands (19.4%).

The most common combinations (> 5%) of types of resistance used were: free weights and machines and bodyweight (26.4%); only bodyweight (16.1%); only machines (10.7%); free weights and bodyweight (10.7%); all four types (9.9%); free weights and machines (7.0%); and machines and bodyweight (6.6%).

Barriers

Among participants who reported not engaging in MSAs, the most common reasons were a lack of time and having no specific reason (33.0% each), followed by a lack of enjoyment (26.6%). Considerably fewer participants indicated the following barriers: a lack of equipment (11.0%), a lack of knowledge (9.2%), health not good enough (9.2%), fear of looking too muscular (4.6%), and health concerns (1.8%). No participant indicated that they had been advised not to do MSAs. Four participants (3.7%) preferred not to answer. Based on the remaining free-text responses, we created an additional category, which pertained to personal factors, such as a lack of motivation or discipline (4.6%). One participant (0.9%) provided a unique free-text response, in that their sport already trains their skeletal muscles.

Associated factors

The multivariate logistic regression models used to evaluate the factors associated with MSAs guideline adherence, the types of resistance used, and the barriers to MSAs yielded only few statistically significant results, as summarized in Table 2. While gender was associated with MSAs guideline adherence (higher odds among males than females), higher age was significantly associated with lower odds of utilizing free weights or machines. Lastly, we found higher odds of reporting a lack of time as a barrier to MSAs in individuals with medium education status as compared to individuals with high education status.

Discussion

The present research found that around two-thirds of the 351 predominantly young and middle-aged, well-educated, and generally physically active adults from our sample engaged in MSAs. However, fewer than one in four persons met the WHO guideline on MSAs. Using one's own bodyweight was the most-utilized type of resistance. The most common barriers to engaging in MSAs included having no specific reason for doing so, a lack of time, and a lack of enjoyment. Demographic factors associated with practices of and barriers to MSAs were identified, including a gender difference in the adherence to the MSAs guideline, with males being more likely to meet the guideline than females.

Discussion of the findings

Our result regarding relatively low MSAs guideline adherence is in line with other studies on the topic [9, 16, 17, 27]. Of note, these findings also echo a previous result of not involving all major muscle groups as a major obstacle to MSAs guideline adherence [17], therefore underscoring the importance of not only assessing MSAs frequency for inferring MSAs guideline adherence. Our finding of greater MSAs guideline adherence among males than females is also in line with previous studies [16, 27], although we did not find robust evidence of other demographic or health-related factors being associated with MSAs guideline adherence. Collectively, our findings emphasize the need for promoting MSAs on a large scale in order to increase MSAs uptake – about one third in the generally physically active sample in our study did not engage in MSAs at all – and MSAs guideline adherence. Encouraging participation in MSAs is of great importance as at least some of the health benefits of MSAs are incremental to the benefits aerobic activities like running or cycling confer [7, 9, 28].

Our findings regarding the utilization of the different types of resistance that may be used for performing resistance training (i.e., the primary form of MSAs) further provide interesting insights here: Bodyweight was the most-utilized type of resistance, followed by free weights and machines. In contrast, far fewer participants reported

Table 2 Results of the logistic regression models on the factors associated with MSAs guideline adherence, utilized types of resistance, and barriers to MSAs

			Types of resistance				Barriers		
Variable	Category (where applicable)	MSAs guideline adherence	Free weights	Machines	Resistance bands	Bodyweight	Lack of time	No specific reason	Lack of enjoyment
N		349	241	241	241	241	108	108	108
McFadden's pseudo R^2		0.055	0.109	0.037	0.018	0.044	0.051	0.051	0.029
Gender	Female	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Male	**1.79 (1.06–3.07)**	1.53 (0.86–2.78)	0.85 (0.49–1.48)	0.75 (0.38–1.47)	1.18 (0.62–2.22)	1.05 (0.43–2.50)	0.44 (0.18–1.05)	1.12 (0.45–2.77)
Age		0.98 (0.96–1.01)	**0.95 (0.93–0.98)**	**0.97 (0.94–0.99)**	1.00 (0.97–1.03)	0.99 (0.96–1.01)	1.00 (0.97–1.03)	1.02 (0.99–1.05)	1.00 (0.97–1.03)
Educational level	High	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Medium	0.70 (0.36–1.32)	0.64 (0.32–1.31)	0.82 (0.42–1.60)	1.00 (0.42–2.23)	0.76 (0.36–1.66)	**3.18 (1.24–8.36)**	0.47 (0.16–1.26)	0.42 (0.12–1.22)
	Low	0.21 (0.01–1.10)	0.71 (0.15–3.19)	1.40 (0.35–6.43)	0.56 (0.03–3.33)	0.61 (0.15–2.70)	2.68 (0.62–11.44)	0.66 (0.14–2.74)	0.43 (0.06–2.12)
Body Mass Index		0.93 (0.86–1.00)	0.94 (0.86–1.02)	1.04 (0.96–1.14)	0.93 (0.83–1.03)	0.92 (0.84–1.00)	1.00 (0.91–1.11)	0.97 (0.87–1.07)	0.99 (0.89–1.10)

Reported are ORs and the corresponding 95% CIs. Bold values signify statistical significance as assessed via the 95% CI. Gender, age, educational level, and BMI served as independent variables in all regression models. Only the top three barriers to MSAs were investigated in regression analyses. Note that $n = 2$ participants were excluded from all regression analyses due to their gender responses. Abbreviation: MSAs = muscle-strengthening activities

using resistance bands. This suggests that resistance bands in particular may be an underutilized type of equipment for performing MSAs. Indeed, resistance bands can be a viable option for performing effective resistance training [29–32], further underscoring the potential of this cheap, versatile, portable, and easy-to-use type of equipment for undertaking MSAs. Resistance bands may thus complement the use of one's bodyweight to establish effective gym-independent MSAs protocols – for example, for individuals to whom the gym setting is a barrier or those who cannot afford a gym membership. Interestingly, the use of the different types of resistance also varied by age, to some extent. This suggests that individual preferences, which may be associated with demographic factors, should be considered when counselling individuals on MSAs.

Our results regarding the reasons for not engaging in MSAs provide additional insights for promoting MSAs. The top answers given by participants in our study were that there was no specific reason for not engaging in MSAs, and a lack of time. Regarding the former, in the absence of clear reasons *against* engaging in MSAs, persons might simply have to be provided with clear reasons *for* performing MSAs. Given the historical dominance of aerobic activities in physical activity recommendations [33], it is perceivable that many people are still not aware of the manifold benefits MSAs provide for health and well-being, often only associating MSAs with athletes like bodybuilders. These misconceptions might be corrected through systematic information and promotion campaigns. However, alternative explanations for the popularity of this response cannot be ruled out entirely and may include a lack of awareness or difficulties in articulating barriers to engaging in MSAs. It is also possible that our questionnaire was unable to capture more nuanced motivational or contextual factors at this point; qualitative interviews may prove useful to capture such nuanced accounts.

A lack of time was the second, most common reason for not engaging in MSAs. A lack of time is a classic barrier to engaging in physical activity and exercise [18, 19, 23]. Importantly, though, there are various options for designing highly time-efficient MSAs programs [ref. 32 for a review on resistance training specifically], with which the MSAs guideline could be met without a large time investment (e.g., using time-saving strategies like supersets). Correcting the misbelief that engaging in MSAs necessitates a large time commitment and providing individuals with actionable, time-saving MSAs protocols might prove useful for increasing MSAs uptake.

The third-most common reason for not performing MSAs was a lack of enjoyment. The last years have seen a spark in approaches within exercise psychology that focus on the affective responses to exercise [34], i.e., the feelings accompanying exercise. Various factors, including the physical or social environment or the somatosensory effects of exercise, can be modified to make exercise more enjoyable [34]. A recent exemplary study found that self-selecting the weights in resistance training led to more positive affect as compared to imposed weights, while inducing similar physiological adaptations [35]. Approaches like these should be explored further. Similarly, personalizing interventions aimed at promoting MSAs through improving the affective responses could leverage currently underutilized intervention targets such as implicit motives (i.e., non-conscious, affect-based motivational dispositions) [36; 37]. Other approaches considering motivational factors may include initial assessment of an individual's motivational dispositions, which can later be used in personalized strategies for goal setting or creation of positive visions [38]. All of these approaches may prove useful for making MSAs more enjoyable, thereby increasing their uptake and maintenance. In this context, activities other than resistance training – which may still be classified as MSAs and perceived as more enjoyable by some – should also be promoted. These include, but are not limited to, yoga, pilates, tai-chi [39], martial arts, and alpine skiing [40].

As with the types of resistance used, there was also some evidence suggesting that sociodemographic variables might be associated with barriers to MSAs. This further underscores the need for (semi-)individualized approaches to MSAs promotion.

In interpreting our findings, it is also important to keep in mind the rather selective sample in our study: Due to our recruitment strategy, the sample mainly consisted of young and middle-aged, well-educated, and generally physically active individuals; generalization to the general population is therefore not possible. However, our results provide important insights into the barriers that even such persons experience, despite their already physically active lifestyles and/or contact with exercise-promoting environments. Hence, our results may inform interventions targeted at these individuals. For example, this may include sharing information materials on the health benefits of MSAs in universities or offering enjoyable and time-efficient MSAs programs in fitness centers.

Limitations and directions for future research

Our study has various limitations. First, as we recruited a convenience sample, our findings are not generalizable. In particular, a strikingly high proportion of participants reported engaging in MSAs, which is likely related to our recruitment strategy (e.g., recruiting in fitness centers). Nevertheless, our sample still showed heterogeneity in terms of sociodemographic and physical activity-related characteristics. Additionally, our rather specific sample allowed us to examine the residual barriers to MSAs in those who are already physically active and/or immersed in exercise-promoting environments, as described above. Second, we focused on resistance training as the central form of MSAs. While this allowed us to study resistance training in greater detail (e.g., the types of resistance used), it may be worthwhile to extend the scope of MSAs to also include activities other than resistance training, including those mentioned above. Third, due to relatively low participant numbers in some of the subgroups, we had suboptimal statistical precision, as evidenced by broad 95% CIs in the regression models; future investigations with more participants are warranted to improve statistical precision.

Conclusion

Fewer than one in four participants met the WHO guideline on MSAs in our study. Bodyweight was the most-utilized type of resistance for performing MSAs. Promoting resistance bands as an underutilized type of resistance might prove useful for increasing engagement in MSAs. Major barriers to engaging in MSAs included a lack of time and enjoyment, but also having no specific reason for doing so. These insights may provide starting points for promoting MSAs, including informing individuals about the health benefits of MSAs and providing time-efficient and enjoyable MSAs protocols.

Appendix

Adaptation of the MSAs questionnaire

The original MSAs questionnaire described in detail in ref. [17] was slightly adapted for use in the current study. Specifically, the following changes were made:

- The wording was further improved at various instances.
- In line with the WHO guidelines [2], we summarized the muscle groups "front of the thigh" and "back of the thigh/buttocks" into only one muscle group "legs". This reduced the total number of major muscle groups from seven to six.
- Additional questions on utilized type(s) of resistance and barriers to MSAs.

The German version of the questionnaire as it was used in the present study and an English translation can be found on the Open Science Framework [25].

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Authors' contributions JB: Conceptualization, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing FH: Visualization, Writing – review & editing MGK: Conceptualization, Data curation, Investigation, Methodology, Project administration, Software, Supervision, Validation, Writing – review & editing.

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Data Availability The datasets generated and/or analyzed and the R code used during the current study are available from the corresponding author upon reasonable request.

Data and Code Availability The datasets generated and/or analyzed and the R code used during the current study are available from the corresponding author upon reasonable request.

Declarations

Competing interests The authors declare no competing interests.

Ethics approval The study does not contain patient data. It complied with the Declaration of Helsinki. In addition, the clarification of potential legal and ethical objections by the self-assessment of the Joint Ethics Committee of the Bavarian Universities (GEHBa) took place.

Infomed Consent All participants provided informed consent at the beginning of the survey.

Declaration of generative AI and AI-assisted technologies in the writing process During the preparation of this work JB used Perplexity AI and ChatGPT in order to generate and double-check parts of the R code. After using Perplexity AI and ChatGPT, JB reviewed and edited the content as needed and takes full responsibility for the content of the published article.

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