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# BMJ Open

## Identifying physical and psychological risk factors for musculoskeletal pain in student musicians to tailor the curriculum: a cross-sectional study protocol

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Manuscripts

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3 **Identifying physical and psychological risk factors for musculoskeletal pain in**  
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6 **student musicians to tailor the curriculum: a cross-sectional study protocol**  
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**BMJ Open****Identifying physical and psychological risk factors for musculoskeletal pain in student musicians to tailor the curriculum: a cross-sectional study protocol****ABSTRACT:**

**Introduction:** Musicians, when they engage in professional practice, are strongly exposed to musculoskeletal pain risks, without the risk factors being well identified. To support positive music learning and good mental, physical and social health, student musicians need health support tailored to their needs and their instrumental practice. However, these preventive actions must be based on sound scientific approaches that reliably identify the most relevant risk factors. The MuSa study is a prospective cross-sectional study that aims to examine the risk variables associated with student musicians' practice-related pain.

**Method and analysis:** The design is a monocentric cross-sectional study among student musicians in bachelor 1, 2, 3 and master 1, 2. Free-form questions will identify students' lifestyle characteristics and work habits and validated questionnaires will evaluate the interaction between pain due to music practice and psychological and physical risk factors. All data will first be analyzed descriptively. To explore the overall correlational structure of our data set, we will use Psychological Network Analysis. A subgroup comparative analysis will be applied according to the instrumental subcategories and work postures.

**Ethics and dissemination:** The full protocol was approved by the Swiss Ethics Committee "Commission cantonale d'éthique de la recherche sur l'être humain de Genève" (CCER, no. 2022-02206) on 13.02.2023. Outcomes will be disseminated through publication in peer-reviewed journals and presentations at conferences.

**Study start:** March 2023 / **Study completion:** July 2023

1  
2  
3 **Registration:** non-applicable  
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6 **Protocol version:** V1 (December 2022)  
7  
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9 **Provenance and peer review:** Not commissioned; externally peer reviewed.  
10

11 **Patient and public involvement:**  
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14 This study does not involve patients or the general public. Music professors from the Geneva  
15 University of Music (Haute école de musique de Genève, HEM) participated in the conception of this  
16  
17 study.  
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20  
21 Thus, it is a co-production between health researchers and music professors, integrating pedagogical  
22  
23 experience and observations of musicians in the learning phase.  
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27 **AUTHOR CONTRIBUTIONS**  
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29  
30 All authors have contributed substantially to conception, design, drafting and revising of the article.  
31

32 All authors approved the final version.  
33

34  
35 CJ: conceived and designed the study, drafted and revised the manuscript; AS: participation in the  
36  
37 conception of the study and management of the REDCap platform ([https://www.project-](https://www.project-redcap.org/)  
38  
39 redcap.org/); DAGD: management of the REDCap platform; AVB – as the study’s principal investigator  
40  
41 – conceived and designed the study, funds raising, management of the project, drafted and revised  
42  
43 the manuscript.  
44  
45

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48

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53  
54

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57  
58 None.  
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3 **Data availability statement:**  
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6 Data supporting the findings of this study are available from the corresponding author [AVB], upon  
7  
8 reasonable request.  
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14 **WORD COUNT: 3537**  
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16  
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19 **Key Words:**  
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21  
22 Student musicians - Pain – Musculoskeletal – Stress – Physical Activity – Risk factors  
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31 **STRENGTHS AND LIMITATIONS (5 bullet points)**  
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- The main objective of this study is to identify the risk factors for musculoskeletal pain associated with student musicians' playing practice.
  - Free-form questions will identify students' lifestyle characteristics and work habits
  - Validated questionnaires will evaluate the interaction between pain due to music practice and psychological and physical risk factors.
  - The study was designed with the involvement of professional music teachers
  - The proportion of musicians not participating in the survey may result in an overestimation of the proportion of musicians experiencing pain

## MAIN TEXT

# Identifying physical and psychological risk factors for musculoskeletal pain in student musicians to tailor the curriculum: a cross-sectional study protocol

## INTRODUCTION

Musculoskeletal health plays a central role in people's daily lives, as it guarantees autonomy and unrestricted participation in socio-professional and leisure activities [1]. When a musculoskeletal disorder (MSD) occurs, it first affects physical, then also mental and social well-being [2]. The constant increase in reported MSD in recent years (+62% in 25 years) [2] highlights the importance of redirecting care towards primary prevention rather than biomedical treatments, as these are often ineffective once the injury has set in [3]. This preventive approach is in line with the United Nations 2030 Agenda for Sustainable Development, and directly related to Goal 3 "Good health and well-being" [4]. In general, the recommended strategies for limiting MSDs are [3]: 1) to develop preventive actions, 2) to carry out close monitoring of physical, psychological and functional capacities in order to identify risk factors at an early stage and 3) to include musculoskeletal health in national policies in order to develop an effective care approach that takes into account the multiple components of MSDs and allows individuals to actively participate in care. Thus, it seems particularly salient, for activities at risk, to determine the risk factors in order to develop effective preventive approaches by promoting individuals' active participation in their health.

Occupational activities involving high physical strain combined with repeated stressful situations are associated with a significant increase in MSDs [5]. Musical practice induces intense repeated movements (with the characteristic of being complex and at high speed), and a high psychosocial

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2  
3 demand [6,7]. Whereas moderate intensity artistic practices have beneficial effects on health [8],  
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5 intensive practice is a risk factor, which should be considered early in the learning process [6]. In fact,  
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7 in children and adolescents, it is the progressive specialization of the practice that constitutes the  
8  
9 main risk factor for health problems. A specialized activity is defined as training throughout the year  
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11 (> 8 months per year), with the renunciation of other activities to focus on learning this one [9].  
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14  
15 Children and teenage musicians who aim to become professional musicians begin their training at a  
16  
17 very early age and are almost always involved in specialized instrumental practice, which exposes  
18  
19 them to an increased risk of MSDs. For other artistic practices (e.g. dance), previous studies have  
20  
21 shown that the transition from leisure practice to professional practice is a particularly critical time  
22  
23 for health problems to arise [10]. From the moment students enter higher education, the volume and  
24  
25 intensity of work increases sharply and the competition is tough. The difference between success and  
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27 failure is played out on stage, in front of an informed public, creating tension [11]. However, this  
28  
29 moment of transition regarding MSD risks has not been thoroughly studied among student  
30  
31 musicians, although the professors of the Geneva University of Music (HEM) report fragility and  
32  
33 difficulties in managing health problems in their students. Moreover, student musicians need health  
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35 support tailored to their needs and specific instrumental practice.  
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40 Despite the known risks and the fact that musical practice can be assimilated to physical activity  
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42 because of the repetition and the intensity of complex movements [12], musicians rarely benefit  
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44 from health support in their learning process and during their professionalization. Yet, the injury rate  
45  
46 is as high as in many sports disciplines and the characteristics of pain origin are quite similar:  
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48 specialization of the activity, intense physical and mental demands, early learning, performance, and  
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50 competitions.  
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54 In a 2018 European study involving 560 student musicians, 65% of participants reported  
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56 musculoskeletal pain related to music practice over the past 12 months [6]. A systematic review of 21  
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58 articles (5424 musicians) dealing with MSDs in musicians showed that the prevalence varied from 41  
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3 to 93% [13]. The pain, even if it does not have a clearly identified cause, generates significant mental  
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5 and physical fatigue that affects quality of learning in student musicians, or even requires a career  
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7 break [6]. The upper limbs and the neck seem to be the most affected areas [13–15], but the  
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9 locations vary according to the position of the upper limbs on the instrument [6] and the general  
10  
11 posture [16].  
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15 The risk factors for musicians' health problems are still relatively unidentified and seem very  
16  
17 contextual. Suggested main risk factors are type of instrument, posture, gender, sedentary lifestyle,  
18  
19 perfectionism, anxiety, stress and working methods [6,13,15,17]. In dancers and athletes, risk factors  
20  
21 are usually separated into intrinsic and extrinsic factors [18]. Foxman et al. propose the same  
22  
23 classification for musicians [7]. Intrinsic factors would be age, gender, past injuries, vulnerability to  
24  
25 stress, laxity, physical abilities (e.g., muscle tone and strength), as well as personality traits (some  
26  
27 people are more resistant to stress than others, which influences performance appraisal) [7,19,20].  
28  
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30 Extrinsic factors include learning conditions, instrumental technique and environment [7].  
31

32 Specifically, technical demands, physical constraints, training errors, lack of planning (periodization),  
33  
34 environmental conditions (e.g., during concerts: temperature, lighting, audience, other performers),  
35  
36 footwear and clothing, and ancillary activities may be additional risk factors. Inappropriate  
37  
38 movement patterns that are repeated due to the above mentioned factors, will be imprinted in the  
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40 brain similarly to optimal ones [11]. Therefore, in instrumental practice and singing, it is crucial to  
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42 identify these particularities allowing approaches adapted to each context and to each individual.  
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46 This should be done as early as possible because ingrained movement and brain patterns are difficult  
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48 to rectify. Existing systematic reviews emphasize that studies on MSDs in musicians typically involve  
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50 small sample sizes and insufficient valid assessment tools [13]. Some authors developed validated  
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52 questionnaires to assess musculoskeletal pain [14,21] and anxiety performance [22] in musicians that  
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54 should be more widely used. While many studies have been published on preventive actions in  
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56 dancers and athletes, a recent systematic review highlights the absence of studies evaluating the  
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58 effectiveness of MSD preventive actions in musicians [23].  
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3 In view of the existing literature and its shortcomings, as well as the very contextual aspect of this  
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5 problem, we will conduct a cross-sectional study in order to gain a better understanding of the health  
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7 status of student musicians at the HEM and more precisely identify the risk factors for pain and  
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9 MSDs. Moreover, the statistical approach by psychological network analysis has never been used,  
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11 although it should be particularly relevant for identifying the strength of the relationships between  
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13 risk factors and pain/MSDs [24]. This first study will provide a solid scientific basis for developing  
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15 preventive actions that will then be the subject of new studies in this field. The concrete application  
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17 is to develop a health strategy for the HEM and transposing the developed knowledge and skills to  
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19 other institutions related to musicians.  
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## 27 **OBJECTIVES**

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29 This cross-sectional study has two aims:

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32 1. To describe the prevalence of playing-related musculoskeletal pain among student  
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34 musicians;
- 35  
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37 2. To identify the physical and psychological risk factors of the self-reported musculoskeletal  
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39 pain among music students.  
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43 Our main hypothesis is that over 65% of student musicians have a history of MSDs and pain, half of  
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45 which would be directly attributable to music playing [6,13]. The risk factors that are most likely to  
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47 influence the onset of pain and MSDs related to instrumental playing would be age, gender, number  
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49 of hours of practice per day, lack of warm-up exercises and breaks, sedentary lifestyle, sleep duration  
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51 (physical factors), and self-perceived health, stress, personality traits and perfectionism  
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53 (psychological factors).  
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## METHODS AND ANALYSIS

### 1. Design and setting

The design is a monocentric cross-sectional study among student musicians at the HEM.

### 2. Participants

The population studied consists of students of the HEM – Geneva and Neuchâtel sites (all disciplines involving playing a musical instrument or singing). The HEM has 615 students from all five continents, nearly 90% of whom are performers. About 250 of them are enrolled in the Bachelor's program and more than 300 in the various Master's programs (mainly concert, soloist and pedagogy orientations) within the different departments of the institution. Since the study involves music students in higher education, recruitment in the HEM institution is appropriate and representative of all categories of the music curriculum.

#### Inclusion criteria

Students may be included if they are regularly enrolled at the HEM, adult (over 18), in the following study years: Bachelor 1, 2, 3 or Master and with a main discipline in musical instrumental practice or singing.

#### Exclusion criteria

- Students enrolled in composition and “music and movement department” (less intense instrumental practice);
- Students who underwent surgical interventions in the last 12 months.

The project voluntarily addresses a large population in order to obtain a global view of the students at the HEM and to have enough respondents to apply valid statistics.

### Recruitment

Information sessions will be offered to explain the project to all students: the nature of the study, its purpose, the procedures involved, the expected duration, the potential risks and benefits, and any discomfort it may cause. Interested parties will receive the information sheet. These sessions will ensure that all of the students' questions are addressed. After these sessions, an email will be sent to briefly explain the project. After a minimum of 24 hours following the information, student volunteers will be able to sign the consent letter and complete the questionnaires online. The study was approved by the ethical committee (CCER Geneva 2022-02206).

### 3. Outcomes

Table 1 lists all questionnaires. The RedCap platform (<https://www.project-redcap.org/>) was used to format the questionnaires and manage the data collection. Participants can choose to respond in English or French as both versions will be available.

*Please insert Table 1.*

Table 1. Free questions and all validated questionnaires.

Tools	Survey name	Brief explanation	References
Free questions		Socio-demographic factors, health habits, musical practice habits	Inspired by Cruder et al. (étude RISMUS) [6] and HEM music professor
Pain in musicians	MPIIQM	Questionnaire on pain locations and its consequences for instrumental practice.	[14]
General health	Self-rated health (SRH)	4-items about self-reported health status	[6,25]
Physical activity	IPAQ-SF	Assessment of physical activity level by intensity (low, moderate and high)	[6,26]

Stress	Kessler Psychological Distress Scale (K10)	10-items on specific emotions measuring anxiety and depression	[27]
Performance anxiety	Kenny Music Performance Anxiety Inventory (K-MPAI-R)	40-items measuring performance anxiety.	[22]
Perfectionism	MPS-25	25-items to evaluate the motivations underlying perfectionism	[28]
Fatigue	Chalder Fatigue Scale (CFQ11)	Evaluation of the severity of physical and psychological fatigue with a 4-point response	[29]
Personality traits	10-item Big Five Inventory	10-items to identify personality traits	[30]

### Primary outcome

The primary outcome is the Musculoskeletal Pain Intensity and Interference Questionnaire developed for professional orchestra Musicians (MPIIQM), which will identify the prevalence of pain related to musical instrumental practice or singing. This questionnaire has been validated with professional orchestra musicians [14]. The MPIIQM consists of 22 questions, 8 of which are used to collect information about the musicians and their practice and 14 questions specifically address pain during or following music practice. This questionnaire includes a subscale of pain intensity (from 0 to 40) and interference of pain with music practice and daily activities (from 0 to 50); it is recommended to use means (or another index of centrality) for the interpretation of these scores. A score of 0 represents respectively absence of pain and no interference of the latter with daily activities, and a score of 10 (averaged scores) an extremely intense pain and strong interference with daily life and, more particularly with instrumental practice. We adapted a minor set of very specific questions on orchestra playing to our student musicians' setting, staying as close as possible to the original text.

### Secondary outcomes

Secondary outcomes were selected to identify risk factors for musculoskeletal pain in musicians.

- *Free questions*

The questions inform on the background of the students while identifying certain risk factors. These questions comprise 3 components: 1) socio-demographic, health and clinical items (age, sex, height, weight, manual laterality, student job, health and cursus history); 2) lifestyle (rest, diet, sleep, addictive behaviors); 3) questions about musical practice (age of commencement, primary and secondary instrument, number of hours spent practicing in courses at the HEM per day, number of hours spent practicing alone per day academic level, breaks during practice, warm-up and cool-down exercises).

- *Self-rated health*

The "Self-rated health" (SRH) is a tool that allows the respondent to self-assess his or her general health [25]. It allows an assessment of health in comparison to the past and to a peer group, and of the limitation of activities as a consequence of health conditions. This scale consists of four questions to be scored on a 3-point Likert-type scale (Table 2). A high score represents good general health.

*Please insert Table 2.*

Table 2. Self-rated health questionnaire

Item s	Questions	Answers		
1	How would you rate your general health status?	Bad	Reasonnable	Good
2	How would you rate your general health status compared to 5 years ago?	Worse	About the same	Better
3	How would you rate your health status compared to others in your age group?	Worse	About the same	Better
4	Do you think your health prevents you from doing things you would like to do?	To a great extent	Partly	Not at all

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3                   - *Physical activity*  
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6           The International Physical Activity Questionnaire-Short Form (IPAQ-SF) is a questionnaire validated in  
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8           English and French that evaluates physical activity as a whole, the level of sedentariness as well as the  
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10           intensity of physical activities performed during the last 7 days [26]. This tool assesses vigorous and  
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12           moderate physical activity, walking, and sitting, and the time spent doing these different activities. The  
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14           short version used includes 7 questions. The IPAQ-SF allows a classification according to three levels  
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16           of physical activity [31]: inactive, moderate (moderately active) and high (health-promoting physical  
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18           activity). The "high" level corresponds to individuals who are active beyond the public health  
19  
20           recommendations (1.5-2h/day); the "moderate" level is determined according to 3 criteria (+20min  
21  
22           intense/day for 3 days or 30min moderate minimum/day for 5 days or 600min/week all activities  
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24           combined); the "inactive" level corresponds to individuals who do not meet the above criteria.  
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31                   - *Stress scale*  
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34           The Kessler Psychological Distress Scale (K10) is a validated scale designed to provide a global measure  
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36           of mental load, based on questions about the anxiety and depressive symptoms a person has  
37  
38           experienced in the past month (4 weeks)[32]. This scale includes 10 questions using a 5-point Likert-  
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40           type scale, with scores ranging from 10 to 50.  
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43           Four categories are used to interpret this test [32] :

- 44  
45           - low score (10-19) corresponding to a state of good mental health;  
46  
47           - lower average score (20-24) corresponding to low psychological distress;  
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49           - higher average score (25-29) corresponding to moderate psychological distress;  
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51           - high score (30-50) corresponding to severe psychological distress.  
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58                   - *Performance anxiety*  
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The Kenny Music Performance Anxiety Inventory (K-MPAI-R) is a validated questionnaire measuring performance anxiety specifically in musicians [19,22]. It includes 40-items using a 7-point Likert-type scale to measure the discomfort caused by anxiety in association with musical performance. A high total score corresponds to a high level of anxiety and distress regarding musical performance and vice versa.

- *Motivations underlying perfectionism*

The "Perfectionism Motivation Questionnaire" (MSP 25 items) is a validated questionnaire that provides an overview of perfectionism and its underlying factors in an individual (Table 3) [28]. This tool separates self-determined and non-self-determined factors using 7 subscales: intrinsic motivation (4-items), identified regulation (3-items) for the self-determined factor (3-items): introjected regulation (3-items), social external regulation (6-items), positive and negative material external regulation (3 items each) and amotivation (3 items). The MSP includes 25 items all together, answered on a 7-point Likert-type scale.

A high score on a subscale ("Questions" in Table 3) indicates a strong association between that factor and perfectionism.

*Please insert Table 3.*

*Table 3. Perfectionism Motivation Questionnaire.*

People can exhibit varying degrees of perfectionism. In this questionnaire, we want to examine the reasons why people are perfectionists. To answer the questions presented below, refer to your field of study in music. For each question, begin the sentence with: "I am a perfectionist..."							
Questions	Does not correspond me at all	Corresponds me very little	Corresponds me a little	Corresponds me moderately	Corresponds me quite a bit	Corresponds me a lot	Exactly corresponds me
...because it brings me closer to the first place and the concrete privileges that come with it							
...because I feel guilty when I cannot meet my success criteria							
...although I do not see what this gives me							
...because getting closer to perfection gives me a pleasant energy							
...because it allows me to avoid the disapproval of my relatives							



1	...because it allows me to avoid dangers or accidents that could harm me or my loved ones						
2	...						
3	...because it allows me to be fully committed in what is important to me						
4	...						
5	...because it allows me to be respected by others						
6	...						
7	...because it gives me access to honors, first place, etc.						
8	...						
9	...because it allows me to be appreciated by some people						
10	...						
11	...even if I have no good reason to be						
12	...						
13	...because it is a good way to realize my projects						
14	...						
15	...because it reassures me not to break or damage my objects by accident.						
16	...						
17	...because I am disappointed in myself when I do not act perfectly						
18	...						
19	...to show others what I am worth						
20	...						
21	...because at the end of the day, there is something to gain (e.g.: medal, award of excellence, prize, money, scholarship, etc.)						
22	...						
23	...because it allows me to feel emotions that I like						
24	...						
25	...because I make sure I do not cause problems that could harm me or my relatives						
26	...						
27	...to avoid disappointing some people						
28	...						
29	...because I feel pleasure when I surpass myself						
30	...						
31	...because it provokes pleasant sensations in me						
32	...						
33	...although it does not make any difference whether I engage in perfectionism or not						
34	...						
35	...because it allows me to reach my goals						
36	...						
37	...because I would blame myself for not doing things perfectly						
38	...						
39	...because if it's not perfect, I could lose my reputation						
40	...						

- *Fatigue*

The Chalder Fatigue Scale (CFQ11) is a self-administered questionnaire that measures the extent and severity of physical fatigue (items 1-7) and psychological fatigue (items 8-11) [29]. This scale consists of 11 questions answered on a 4-point scale, with scores ranging from 0 to 33. The total scores can be calculated globally or by using the 2 subscales (physical and psychological fatigue) separately. According to this rating, a low score corresponds to low fatigue and vice versa [33]. It can also be scored using a binary notation, for scores ranging from 0 to 11 (the first two responses being worth 0

1  
2  
3 and the next 2 being worth 1); this scoring separates respondents into 2 categories: with a score of 3  
4 or less, people who are not very fatigued and with a score of 4 or more, people with "severe fatigue".  
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6

7  
8 - *Personality traits*  
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10  
11 The Big Five Inventory (BFI-10) is a short version of a questionnaire used to identify personality traits  
12 according to a five-factor model [30]. The BFI-10 includes 5 two-item scales that place the respondent  
13 on one of five personality dimensions: extraversion, agreeableness, conscientiousness (professional),  
14 neuroticism and openness (to experience). This tool uses 10 items using a 5-point Likert-type scale,  
15 ranging from "strongly approve" to "strongly disapprove". A high score on any of the subscales means  
16 that this dimension represents a characteristic trait of the respondent's personality.  
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28 **4. Bias**  
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30 *Refusal to participate*  
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32  
33 There may be a tendency that musician students are more inclined to answer the questionnaire if  
34 they are familiar with musculoskeletal pain. This situation will inflate the prevalence estimate found  
35 in our study sample in case of substantial refusal to participate. We attempt to avoid this problem by  
36 informing the respondents on the importance of their contribution to the study. Moreover, a  
37 comprehensive effort is put into follow-up by contacting as many as possible in the class or with a  
38 reminder mail.  
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47 *Recall bias*  
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49  
50 In order to limit the risk of bias related to the single moment of response, many questionnaires  
51 specify a duration of time to be taken into account for answering (e.g. since 6 months, the last 7  
52 days). In addition, we open the questionnaires during a standard period within the curriculum,  
53 avoiding exams, orchestra sessions or vacations.  
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59

60 *Selection bias*

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3 The HEM allows us to contact 100% of the student musicians. We will inform the students orally and  
4  
5 by e-mail thanks to their institutional e-mail address which they must consult. This way, we make  
6  
7 sure to contact all the students of the target population.  
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### 10 11 12 13 **5. Sample size**

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15  
16 The psychological network method used to explore the overall correlational structure of the data set  
17  
18 does not require a sample size calculation because it is an exploratory analysis. According to the Central  
19  
20 Limit Theorem, a sample size of at least 30 participants is required to obtain a Gaussian distribution  
21  
22 [34,35]. Given the number of students at the HEM, the inclusion of 100 students out of a total available  
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24 number of about 450 students seems realistic.  
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### 31 **6. Data analysis and statistics**

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34 All data will first be analyzed descriptively. For qualitative data, frequencies and percentages will be  
35  
36 calculated. Quantitative data will be reported by means and standard deviations if the data respect  
37  
38 the normal distribution. Otherwise, medians and quartiles will be reported.  
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41  
42 To explore the overall correlational structure of our data sets, we will use the Psychological Network  
43  
44 Analysis with Spearman correlations to be insensitive to outliers and non-normality [24,36]. The  
45  
46 psychological network methodology allows us to visualize all connections between all variables (risk  
47  
48 factors, pain, MSDs, instrumental practice) represented by nodes in a single graphical representation.  
49

50  
51 This method is most appropriate for exploratory analysis when many variables are involved and  
52  
53 specifically recommended for cross-sectional studies with repeated measures [24], like in this study.  
54

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56 The thickness of the edges of the network will represent the strength of the correlations, and the  
57  
58 proximities between the variables will be identified by the absolute value of the Spearman  
59  
60 correlation. The distance between two nodes thus varies inversely with the strength of the absolute

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3 value of the correlational link: highly correlated nodes appear close together, while weakly correlated  
4 nodes appear far apart. This method may allow grouping several closely associated variables into a  
5 so-called “latent variable”, that may shed new light on the origins of MSD, and suggest combined  
6 treatment in future preventive approaches.  
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12 Participants will then be categorized according to the instrumental subcategories and work postures  
13 and results will be compared between groups if the number of students per group is sufficient. The  
14 Chi-square test will be used to compare categorical variables, while continuous variables will be  
15 analyzed by the non-parametric Kruskal-Wallis test. A p-value lower than 0.05 will be considered  
16 significant. As this is an exploratory study, we will report the raw p-values, but also with correction for  
17 multiple comparisons. All statistics will be performed on SPSS or R software.  
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## 30 **DISCUSSION**

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33 The MuSa study is a prospective cross-sectional study that aims to examine the risk variables  
34 associated with student musicians' practice-related pain. The originality of this study resides in  
35 various factors related to its conceptualization and target population. This research project was  
36 entirely co-constructed by scientists in the field of health (Geneva School of Health Sciences, HEdS),  
37 and professional music teachers of the HEM, which allows the protocol to be based on scientific  
38 knowledge, but also on feedback from the field. This point is extremely important in order to meet  
39 the demands of the HEM and to put in place an effective health support for student musicians. In  
40 order to meet this dual requirement, free questions were drafted and validated questionnaires were  
41 selected. Numerous pre-tests with HEM assistants and professors were conducted to ensure that the  
42 questions were understood, interesting, and the survey as a whole feasible. Another originality of  
43 this study is collecting both physical and mental risk factors associated with music practice as well as  
44 work habits. The final multivariate statistical approach by means of network analysis may allow  
45 identifying intricate links between these multiple factors around health issues and the detection of  
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3 latent variables that may be both physical and psychological. To reduce bias, we will apply validated  
4 and music-specific questionnaires. Moreover, all HEM students in the curriculum will be contacted  
5 and informed of this study in order to obtain a maximum of participants, studying a large variety of  
6 musical instruments.  
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12 This study provides a basis for the development of numerous approaches for health promotion and  
13 prevention of pain, tailored to the context of student musicians. Based on the most relevant risk  
14 factors related to musician's pain that we hope to reveal, potentially also latent factors based on  
15 strongly associated variables, we will develop more specific research projects. From a practical point  
16 of view, implementation of preventive and adapted actions is planned in order to develop the  
17 students' health awareness taking into consideration the results of this study. The effectiveness of  
18 these actions can then be evaluated and will thus respond to a lack of scientific knowledge on the  
19 effectiveness of preventive actions in the curriculum of student musicians. These perspectives should  
20 improve the mental, physical and social health of the students, which would promote learning in  
21 good conditions, and lead to happier lives and more fulfilled careers.  
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## 40 ETHICS AND DISSIMINATION

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43 **Ethical committee:** Ethics approval has been granted by the Swiss Ethics Committee of the CCER  
44 GENEVA (2022-02206).  
45  
46

47  
48 **Recruitment and consent:** Prospective, written consent will be obtained from all participants.  
49

50  
51 **Data collection, storage and access:** Data will be de-identified and entered into a secure folder and  
52 electronic database. Only the investigators and a statistician will have access to the final dataset.  
53  
54

55  
56 **Dissemination strategy:** Outcomes will be disseminated through publication in peer-reviewed  
57 journals, professional journals, and presentations at national and international conferences.  
58  
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# BMJ Open

## Identifying physical and psychological risk factors for musculoskeletal pain in student musicians to tailor the curriculum: a cross-sectional study protocol

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Secondary Subject Heading:	Diagnostics, Sports and exercise medicine, Public health
Keywords:	Risk Factors, Musculoskeletal disorders < ORTHOPAEDIC & TRAUMA SURGERY, PAIN MANAGEMENT

SCHOLARONE™  
Manuscripts

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3 **Identifying physical and psychological risk factors for musculoskeletal pain in**  
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6 **student musicians to tailor the curriculum: a cross-sectional study protocol**  
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## ***BMJ Open***

# **Identifying physical and psychological risk factors for musculoskeletal pain in student musicians to tailor the curriculum: a cross-sectional study protocol**

### **ABSTRACT:**

**Introduction:** Insufficient identification and understanding of risk factors make musicians engaging in professional practice particularly vulnerable to musculoskeletal pain. To support positive music learning and good mental, physical, and social health, student musicians need health support tailored to their needs and their instrumental practice. However, these preventive actions must be based on sound scientific approaches that reliably identify the most relevant risk factors. MuSa is a cross-sectional study examining contextual and internal risk variables associated with playing-related musculoskeletal disorders (PRMD) in student musicians.

**Method and analysis:** The design is a monocentric cross-sectional study involving student musicians in Bachelor's 1, 2, 3 and Master's 1, 2. Free-form questions will identify students' lifestyle characteristics and work habits, and validated questionnaires will evaluate the interaction between pain due to music practice and psychological and physical risk factors. All data will first be analyzed descriptively. Psychological network analysis will be used to explore the overall correlational structure of the dataset. A subgroup comparative analysis will be will be then applied according to the instrumental subcategories and work postures, including singers.

**Ethics and dissemination:** The full protocol was approved by the Swiss Ethics Committee "Commission cantonale d'éthique de la recherche sur l'être humain de Genève" (CCER, no. 2022-02206) on 13.02.2023. Outcomes will be disseminated through publication in peer-reviewed journals and presentations at conferences.

**Study start:** March 2023 / **Study completion:** July 2023

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3 **Registration:** non-applicable  
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6 **Protocol version:** V1 (December 2022)  
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9 **Provenance and peer review:** Not commissioned; externally peer reviewed.  
10

11 **WORD COUNT:** 3968  
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17 **Key Words:**  
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20 Student musicians – Pain – Musculoskeletal – Stress – Physical Activity – Risk factors  
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29 **STRENGTHS AND LIMITATIONS (5 bullet points)**  
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- 33 • The main objective of this study is to identify the risk factors for musculoskeletal pain  
34 associated with student musicians' playing practice.  
35
  - 36 • Free-form questions will identify students' lifestyle characteristics and work habits.  
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  - 38 • Validated questionnaires will evaluate the interaction between pain due to music practice  
39 and psychological and physical risk factors.  
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  - 41 • The study was designed with the involvement of professional music teachers.  
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  - 43 • Non-participation of musicians in the survey may lead to an overestimation of the proportion  
44 experiencing pain.  
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## MAIN TEXT

# Identifying physical and psychological risk factors for musculoskeletal pain in student musicians to tailor the curriculum: a cross-sectional study protocol

## INTRODUCTION

Musculoskeletal health plays a central role in people's daily lives, as it guarantees autonomy and unrestricted participation in socio-professional and leisure activities [1]. Musculoskeletal disorders (MSD) induce pain, reduce motor function, and impair mental and social well-being [2]. In 2019, three out of five people reported work-related MSD in Europe [3]. Although physical problems generally first set in [3], musculoskeletal disorders can involve physical and mental factors, with each influencing and exacerbating the other [4] and mediated by neurochemistry [5]. This situation highlights the importance of redirecting care toward primary prevention rather than biomedical treatments, as these are often ineffective once the injury has occurred [2]. This preventive approach is in line with the United Nations 2030 Agenda for Sustainable Development and directly related to Goal 3 "Good health and well-being" [6]. In general, the recommended strategies for limiting MSDs are [2]: 1) to develop preventive actions; 2) to carry out close monitoring of physical, psychological, and functional capacities in order to identify risk factors at an early stage; and 3) to include musculoskeletal health in national policies in order to develop an effective care approach that takes into account the multiple components of MSDs and allows individuals to actively participate in care. Identifying different underlying risk factors is crucial for developing effective preventive approaches for high-risk activities.

Occupational activities involving high physical strain combined with psychologically stressful situations are associated with a significant increase in MSDs [7]. Musical practice involves intense,

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3 often complex, rapid movements accompanied by high psychosocial demands [8,9]. Whereas  
4 moderate-intensity artistic practices, including sensorimotor aspects, benefit health [10,11],  
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6 intensive practice is a risk factor that should be considered early in the learning process [8]. In fact, in  
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8 sports, the leading risk factor for health problems in children and adolescents is the increasingly  
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10 progressive specialization of practice at higher levels of performance [12]. A specialized activity is  
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12 defined as training throughout the year (> 8 months per year), with the renunciation of other  
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14 activities to focus on this one [13].  
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19 Children and teenage musicians who aim to become professional musicians begin their training at an  
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21 early age and are quasi-systematically involved in specialized instrumental practice, elevating the risk  
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23 of MSDs. While studies of children with specialization practice are limited, Aparicio et al. (2016)  
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25 found a higher prevalence of pain in musician children compared to non-musicians [14], and 14% of  
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27 adolescent music students report playing-related musculoskeletal disorders (PRMD) [15]. For other  
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29 artistic practices (e.g., dance), previous studies have shown that transitioning from leisure to  
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31 professional practice is a particularly critical time for health problems to arise [16]. When students  
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33 enter higher education, the volume and intensity of practice increase sharply, and the competition is  
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35 intense. The difference between success and failure is played out on stage in front of an informed  
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37 public, creating tension [17]. Studies have shown a higher prevalence of pain, stress, psychological  
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39 issues, and the use of medical treatment among student musicians compared to non-musicians [18–  
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41 21]. Nevertheless, musicians often rate their health status more positively, which could be directly  
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43 linked to the "no pain, no gain" mentality [18]. The prevalence of observed disorders appears to be  
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45 higher among first-year students and in master's degree programs, highlighting the need for  
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47 implementing enhanced prevention programs specifically tailored for new students [19,22]. While  
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49 studying at a conservatory for professional musicians, approximately 10% of student musicians  
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51 experience critical health problems that can significantly impair their learning or require them to stop  
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53 their curriculum [22].  
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3 This transitional period at the start of professional training, which poses increased risks of  
4 musculoskeletal disorders (MSD), has not been thoroughly studied among student musicians.  
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7 However, professors at the Geneva University of Music (Haute école de musique de Genève - HEM)  
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9 observed fragility and encountered difficulties in managing health issues among their undergraduate  
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11 students. Moreover, student musicians need health support tailored to their needs and their  
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13 instrumental practice. Some studies showed a beneficial effect of preventive actions when support  
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15 was adapted to the specific context [19,23].  
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19 Despite the known risks and the fact that musical practice can be compared with physical activity  
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21 because of the repetition and intensity of complex movements [24], musicians rarely benefit from  
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23 the health support found in sports disciplines during their learning process and professionalization.  
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25 Yet, the injury rate is as high as in many sports disciplines, and the characteristics of pain origin are  
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27 similar: specialization of the activity, intense physical and mental demands, early learning,  
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29 performance, and competitions.  
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33 In a 2018 European study involving 560 student musicians, 65% of participants reported PRMD over  
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35 the past 12 months [8]. A systematic review of 21 articles (involving 5,424 professional musicians)  
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37 dealing with MSDs in musicians showed that prevalence varied from 41% to 93% [25]. The pain, even  
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39 if it does not have a clearly identified cause, generates significant mental and physical fatigue that  
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41 affects the quality of learning for student musicians or may even necessitate a career break [8]. In  
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43 professional musicians, the upper limbs and neck seem to be the most affected areas [25–27], but  
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45 the specific locations of disorders vary depending on the positioning of the upper limbs in relation to  
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47 the instrument [8], as well as the overall posture [28].  
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52 Previous studies have suggested the main risk factors to be type of instrument, posture, gender,  
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54 sedentary lifestyle, perfectionism, anxiety, stress, and working methods [8,25,27,29,30]. In dancers  
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56 and athletes, risk factors are usually separated into intrinsic and extrinsic factors [31]. Zaza et al.  
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58 (1993) proposed the same classification for musicians [32]. Intrinsic factors would be age, gender,  
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3 past injuries, vulnerability to stress, laxity, physical abilities (e.g., muscle tone and strength), and  
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5 personality traits (some people are more resistant to stress than others, which influences  
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7 performance experience) [9,33,34]. Extrinsic factors include learning conditions, instrumental  
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9 technique, and the environment [9]. In addition to the type of instrument and the position of the  
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11 arms [8], the main risk factors in student musicians vary across the studies. Ballenberger et al. (2023)  
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13 identified the most critical risks as stress and a history of PRMD [21], while Cruder et al. (2020)  
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15 observed perfectionism, fatigue, and years of practice [8]. Specifically, technical demands, physical  
16  
17 constraints, training errors, lack of planning (periodization), environmental conditions (e.g., during  
18  
19 concerts: temperature, lighting, audience, other performers), footwear and clothing, and ancillary  
20  
21 activities may be additional risk factors. Repeated improper movement patterns, influenced by the  
22  
23 aforementioned factors, can lead to brain plasticity cases similar to those observed with optimized  
24  
25 movement patterns [17]. Some specific risk factors have also been identified according to practice,  
26  
27 for example, singers with 46% of dysphonia over their careers [35] and 13% to 20% of flutists  
28  
29 presenting jaw disorders [36]. In instrumental practice, it is crucial to identify PRMD, MSD, and the  
30  
31 primary risk factors, allowing approaches to be adapted to each context and each individual. Existing  
32  
33 systematic reviews emphasize that studies on MSDs in musicians typically involve small sample sizes  
34  
35 and insufficiently valid assessment tools [25]. Some authors have developed validated questionnaires  
36  
37 to assess musculoskeletal pain [26,37] and performance anxiety [38] in musicians that should be  
38  
39 more widely used. While many studies have been published on preventive actions in dancers and  
40  
41 athletes, a recent systematic review highlights the absence of studies evaluating the effectiveness of  
42  
43 MSD preventive actions in musicians [30].  
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49  
50 Given the existing literature and its shortcomings, as well as the contextual aspect of this problem,  
51  
52 this paper describes a cross-sectional study conducted to gain a better understanding of the health  
53  
54 status of student musicians at the HEM and more precisely identify the risk factors for PRMD and  
55  
56 MSDs. Moreover, the statistical approach of psychological network analysis has not been used  
57  
58 previously, although it is relevant for identifying the strength of the relationships between risk  
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3 factors and PRMDs [39]. Network analysis refers to a statistical approach used in psychological  
4 science to examine and understand complex relationships among multiple variables. It involves  
5 analyzing the interconnections and dependencies between variables to uncover hidden patterns and  
6 dynamics within a system [39]. Network analysis involves visualizing complex relationships among  
7 variables using nodes (representing variables) connected by edges of varying thickness to indicate  
8 the strength of connections. It is a valuable tool for exploring and interpreting relational data,  
9 particularly when dealing with many variables [39,40]. This study will provide a solid scientific basis  
10 for developing preventive actions that will be the subject of new studies in this field. The concrete  
11 application is to develop a health strategy for the HEM and transfer the developed knowledge and  
12 skills to other institutions related to musicians.  
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## 29 **OBJECTIVES**

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32 This cross-sectional study has two aims:

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35 1. To describe the prevalence of playing-related musculoskeletal pain among student  
36 musicians;
- 37  
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39 2. To identify the physical and psychological risk factors for self-reported musculoskeletal pain  
40 among music students.  
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45 Our main hypothesis is that over 65% of student musicians have a history of MSDs and pain, half of  
46 which are directly attributable to music playing [8,25]. Physical risk factors influencing the  
47 development of pain and musculoskeletal disorders (MSDs) in instrumental playing include age,  
48 gender, duration of daily instrumental practice (including individual training and HEM courses), lack  
49 of warm-up exercises and breaks, sedentary lifestyle, and sleep duration. In the psychological  
50 domain, factors such as self-perceived health, stress, and perfectionism play a role [9,33,34]. These  
51 psychological factors align with personality traits based on the Big Five model: openness,  
52 conscientiousness, extraversion, agreeableness, and neuroticism [41].  
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## Methods and Analyses

### Patient and public involvement:

This study does not involve patients or the general public. Music professors from the Geneva University of Music (Haute école de musique de Genève, HEM) participated in the conception of this study.

Thus, it is a co-production between health researchers and music professors, integrating pedagogical experience and observations of musicians in the learning phase.

### 1. Design and setting

The design is a monocentric cross-sectional study among student musicians at the HEM.

### 2. Participants

The population studied consists of students of the HEM – Geneva and Neuchâtel sites (all disciplines involving playing a musical instrument or singing). The HEM has 550 students from all five continents, nearly 90% of whom are performers. Approximately 250 are enrolled in the Bachelor's program and more than 300 in the various Master's programs (mainly concert, soloist, and pedagogy orientations) within the institution's different departments. Since the study involves music students in higher education, recruitment at the HEM institution is appropriate and representative of all categories of the music curriculum.

### Inclusion criteria

Students will be included if they are regularly enrolled at the HEM as adults (over 18) in a Bachelor's (years 1, 2, or 3) or Master's degree with a main discipline in musical instrumental practice or singing.

### Exclusion criteria

- Students enrolled in composition and "music and movement department" (less intense instrumental practice);
- Students who have undergone surgical interventions in the previous 12 months that affect music practice.

The project voluntarily addresses a large population to obtain a global view of the students at the HEM and gain sufficient respondents for statistically valid statistics.

### Recruitment

Information sessions will be offered to explain the project: the nature of the study, its purpose, the procedures involved, the expected duration, the potential risks and benefits, and any discomfort it may cause. Interested parties will receive the information sheet. These sessions will ensure that all students' questions are addressed. After these sessions, an email will be sent to briefly explain the project. After a minimum of 24 hours following the information, student volunteers will be able to sign the consent letter and complete the questionnaires online. The study has been approved by the ethical committee (CCER Geneva 2022-02206).

### **3. Outcomes**

Table 1 lists all the questionnaires. The RedCap platform (<https://www.project-redcap.org/>) was used to format the questionnaires and manage the data collection. Numerous pre-tests with HEM assistants and professors were conducted to ensure the questions were understandable and interesting and that the survey is feasible. Given the high number of international students, the questionnaire is offered in French and English. There will be only one measurement time for each participant. The time required to complete the questionnaires is estimated at 40 minutes.

*Please insert Table 1.*

Table 1. Free questions and all validated questionnaires.

Tools	Survey name	Brief explanation	References
Free questions		Socio-demographic factors, health habits, musical practice habits	Inspired by Cruder et al. (étude RISMUS) [8], exchange with HEM music professors and pre-tests
Pain in musicians	MPIIQM	Questionnaire on pain locations and its consequences for instrumental practice	[26]
General health	Self-rated health (SRH)	Four items about self-reported health status	[8,42]
Physical activity	IPAQ-SF	Assessment of physical activity level by intensity (low, moderate, high)	[8,43]
Stress	Kessler Psychological Distress Scale (K10)	10 items on specific emotions measuring anxiety and depression	[44]
Performance anxiety	Kenny Music Performance Anxiety Inventory (K-MPAI-R)	40 items measuring performance anxiety	[38]
Perfectionism	MPS-25	25 items to evaluate the motivations underlying perfectionism	[45]
Fatigue	Chalder Fatigue Scale (CFQ11)	Evaluation of the severity of physical and psychological fatigue with a four-point response	[46]
Personality traits	10-item Big Five Inventory	10 items to identify personality traits	[41]

### Primary outcome

The primary outcome is the Musculoskeletal Pain Intensity and Interference Questionnaire developed for professional orchestra musicians (MPIIQM), which will identify the prevalence of pain related to musical instrumental practice or singing. This questionnaire has been validated with professional orchestra musicians [26]. The MPIIQM consists of 22 questions, eight of which are used to collect information about the musicians and their practice, and 14 of which specifically address

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3 pain during or following music practice. This questionnaire includes a subscale of pain intensity (0 to  
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5 40) and pain's interference with music practice and daily activities (from 0 to 50). It is recommended  
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7 to use means (or another index of centrality) to interpret these scores. A score of 0 represents the  
8  
9 respective absence of pain and its non-interference with daily activities, and a score of 10 (averaged  
10  
11 scores) represents intense pain and significant interference with daily life and, more particularly,  
12  
13 instrumental practice. A minor set of specific questions on orchestra playing were adapted to student  
14  
15 musician settings (instrumentalists and singers), staying as close as possible to the original text.  
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#### 18 Secondary outcome

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21 Secondary outcomes were selected to identify risk factors for musculoskeletal pain in musicians.  
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##### 23 - *Free questions*

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27 The free-form questions were based on Cruder et al.'s (2020) approach [8] and arose from  
28  
29 discussions with two music teachers, the head of research, and the pedagogical coordinator of the  
30  
31 HEM, as well as on pre-tests with music assistants. The questions help identify the students'  
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33 backgrounds while identifying certain risk factors. These questions comprise three components: 1)  
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35 socio-demographic, health, and clinical items (age, sex, height, weight, manual laterality, student job,  
36  
37 health, and educational history); 2) lifestyle (rest, diet, sleep, addictive behaviors); 3) questions about  
38  
39 musical practice (age of commencement, primary and secondary instrument, number of hours spent  
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41 practicing in courses at the HEM per day/week, number of hours spent practicing alone per  
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43 day/week, academic level, breaks during practice, warm-up and cool-down exercises).  
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##### 47 - *Self-rated health*

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51 The self-rated health (SRH) tool allows respondents to self-assess their general health [42]. The SRH  
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53 outcomes in musicians may have previously been related to the presence of general musculoskeletal  
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55 pathology and not PRMD [8], while health perception appears to be highly influenced by context  
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57 [42]. In addition, SRH appears to be a strong predictor of the onset of arm pain [47], supported by  
58  
59 the fact that musicians have a predominance of PRMD in the upper extremities [25]. This SRH tool  
60

allows an assessment of health in comparison to the past, the same age group, and health conditions' impact on activities. The scale consists of four questions to be scored on a three-point Likert-type scale (Table 2). A high score represents good general health.

*Please insert Table 2.*

Table 2. Self-rated health questionnaire

Item s	Questions	Answers		
1	How would you rate your general health status?	Bad	Reasonabl e	Good
2	How would you rate your general health status compared to five years ago?	Worse	About the same	Better
3	How would you rate your health status compared to others in your age group?	Worse	About the same	Better
4	Do you think your health prevents you from doing things you would like to do?	To a great extent	Partly	Not at all

- *Physical activity*

The International Physical Activity Questionnaire-Short Form (IPAQ-SF) is a questionnaire validated in English and French that evaluates physical activity, levels of sedentariness, and the intensity of physical activities performed during the last seven days [43]. This tool assesses vigorous and moderate physical activity, walking and sitting, and the time spent on these activities. The short version used includes seven questions. The IPAQ-SF allows a classification according to three levels of physical activity [48]: inactive, moderate (moderately active), and high (health-promoting physical activity). The "high" level corresponds to individuals who are active beyond the public health recommendations (1.5-2h/day); the "moderate" level is determined according to three criteria (+20min intense/day for 3 days or 30min

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3 moderate minimum/day for 5 days or 600min/week all activities combined); the "inactive" level  
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5 corresponds to individuals who do not meet the above criteria.  
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10 - *Stress scale*  
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13 The Kessler Psychological Distress Scale (K10) is a validated scale designed to provide a global measure  
14 of mental load based on questions about the anxiety and depressive symptoms a person has  
15 experienced in the past month (4 weeks) [49]. This scale includes 10 questions using a 5-point Likert-  
16 type scale, with scores ranging from 10 to 50.  
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20 Four categories are used to interpret this test [49] :  
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- 23 - low score (10-19) corresponding to a state of good mental health;
  - 24 - lower average score (20-24) corresponding to low psychological distress;
  - 25 - higher average score (25-29) corresponding to moderate psychological distress;
  - 26 - high score (30-50) corresponding to severe psychological distress.
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37 - *Performance anxiety*  
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40 The Kenny Music Performance Anxiety Inventory (K-MPAI-R) is a validated questionnaire measuring  
41 performance anxiety, specifically in musicians [33,38]. It includes 40 items using a seven-point Likert-  
42 type scale to measure the discomfort caused by anxiety associated with musical performance. A high  
43 total score corresponds to high anxiety and distress regarding musical performance and vice versa.  
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49 - *Motivations underlying perfectionism*  
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52 The "Perfectionism Motivation Questionnaire" (MSP 25 items) is a validated questionnaire that  
53 provides an overview of perfectionism and its underlying factors in an individual (Table 3) [45]. This  
54 tool separates self-determined and non-self-determined factors using seven subscales: intrinsic  
55 motivation (four items), identified regulation (three items) for the self-determined factor (three items):  
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introjected regulation (three items), social external regulation (six items), positive and negative material external regulation (three items each) and motivation (three items). The MSP includes 25 items, answered on a seven-point Likert-type scale.

A high score on a subscale ("Questions" in Table 3) indicates a strong association between that factor and perfectionism.

*Please insert Table 3.*

*Table 3. Perfectionism Motivation Questionnaire.*

People can exhibit varying degrees of perfectionism. In this questionnaire, we want to examine why people are perfectionists. To answer the questions presented below, refer to your field of study in music. Each question begins with the sentence, "I am a perfectionist..."							
Questions	Does not correspond with me at all	Corresponds to me very little	Corresponds to me a little	Corresponds to me moderately	Corresponds to me quite a lot	Corresponds to me a lot	Exactly corresponds to me
...because it brings me closer to the top in my music domain place and the concrete privileges that come with it							
...because I feel guilty when I cannot meet my success criteria							
...although I do not see what this gives me							
...because getting closer to perfection gives me a pleasant energy							
...because it allows me to avoid the disapproval of my relatives							
...because it allows me to avoid dangers or accidents that could harm me or my loved ones							
...because it allows me to be fully committed in what is important to me							
...because it allows me to be respected by others							
...because it gives me access to honors, first place, etc.							
...because it allows me to be appreciated by some people							
...even if I have no good reason to be							
...because it is a good way to realize my projects							
...because it reassures me not to break or damage my objects by accident							
...because I am disappointed with myself when I do not act perfectly							
...to show others what I am worth							



...because at the end of the day, there is something to gain (e.g., medal, award of excellence, prize, money, scholarship, etc.)							
...because it allows me to feel emotions that I like							
...because I make sure I do not cause problems that could harm me or my relatives							
...to avoid disappointing some people							
...because I feel pleasure when I surpass myself							
...because it provokes pleasant sensations in me							
...although it does not make any difference whether I engage in perfectionism or not							
...because it allows me to reach my goals							
...because I would blame myself for not doing things perfectly							
...because if it's not perfect, I could lose my reputation							

- *Fatigue*

The Chalder Fatigue Scale (CFQ11) is a self-administered questionnaire that measures the extent and severity of physical fatigue (items 1–7) and psychological fatigue (items 8–11) [46]. The scale consists of 11 questions answered on a four-point scale, with scores ranging from 0 to 33. The total scores can be calculated globally or by using the two subscales (physical and psychological fatigue) separately. According to this rating, a low score corresponds to low fatigue and vice versa [50]. It can also be scored using a binary notation for scores ranging from 0 to 11 (the first two responses being worth 0 and the next 2 being worth 1). This scoring separates respondents into two categories: those who are not very fatigued (a score of 3 or less) and those with severe fatigue (a score of 4 or more).

- *Personality traits*

The Big Five Inventory (BFI-10) is a short version of a questionnaire used to identify personality traits according to a five-factor model [41]. The BFI-10 includes five two-item scales that place the respondent on one of five personality dimensions: extraversion, agreeableness, conscientiousness (professional), neuroticism, and openness (to experience). This tool involves 10 items using a five-point

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3 Likert-type scale, ranging from "strongly approve" to "strongly disapprove". A high score on any of the  
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5 subscale means this dimension represents a characteristic trait of the respondent's personality.  
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#### 10 **4. Bias**

##### 11 Non-response

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16 There may be a tendency for musician students to be more inclined to answer the questionnaire if  
17  
18 they are familiar with musculoskeletal pain. This situation will inflate the prevalence estimate found  
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20 in the study sample in the event of a substantial refusal to participate. To avoid this problem,  
21  
22 respondents will be informed of the importance of their contribution to the study. Additionally, to  
23  
24 ensure thorough follow-up, we will make contact with all remaining potential participants either  
25  
26 through direct communication or by sending a reminder email.  
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29

##### 30 Recall bias

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33 To limit the risk of bias related to the single moment of response, many questionnaires specify a  
34  
35 period to be taken into account for answering (e.g., in the last six months or the last seven days). In  
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37 addition, the questionnaires were sent during a standard period within the curriculum, avoiding  
38  
39 exams, orchestra sessions, and vacations.  
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##### 43 Selection bias

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46 The HEM allows 100% of the student musicians to be contacted. The students will be informed orally  
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48 and via their institutional email address. This approach ensures that all the students in the target  
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50 population are contacted.  
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#### 56 **5. Sample size**

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2  
3 The psychological network method used to explore the overall correlational structure of the data set  
4  
5 does not require a sample size calculation because it is an exploratory analysis. According to the Central  
6  
7 Limit Theorem, a sample size of at least 30 participants is required to obtain a Gaussian distribution  
8  
9 [51,52]. Given the number of students at the HEM, the inclusion of 100 students from a population of  
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12 450 seems realistic.  
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## 18 **6. Data analysis and statistics**

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20 All data will first be analyzed descriptively. For qualitative data, frequencies and percentages will be  
21  
22 calculated. Quantitative data will be reported by means and standard deviations if the data respect  
23  
24 the normal distribution. Otherwise, medians and quartiles will be reported.  
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28 The psychological network analysis with Spearman correlations will be adopted to explore the overall  
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30 correlational structure of the datasets to ensure the data are insensitive to outliers and non-  
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32 normality [39,40]. The psychological network methodology allows the connections between all  
33  
34 variables (risk factors, pain, MSDs, instrumental practice) to be visualized by nodes in a single  
35  
36 graphical representation. This method is most appropriate for exploratory analysis when many  
37  
38 variables are involved, and it is specifically recommended for cross-sectional studies with repeated  
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40 measures [39], as in this study. The thickness of the edges of the network will represent the strength  
41  
42 of the correlations, and the proximities between the variables will be identified by the absolute value  
43  
44 of the Spearman correlation. The distance between two nodes thus varies inversely with the strength  
45  
46 of the absolute value of the correlational link: highly correlated nodes appear close together, while  
47  
48 weakly correlated nodes appear far apart. This method allows several closely associated variables to  
49  
50 be grouped into a "latent variable" that may shed new light on the origins of MSD and suggest  
51  
52 combined treatment in future preventive approaches.  
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58 Participants will then be categorized according to instrumental subcategories (instrumentalists  
59  
60 according to arm position and singers) and work postures (standing, sitting, or both), and results will

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2  
3 be compared between groups if the number of students per group is sufficient. A Chi-square test will  
4  
5 be used to compare categorical variables, while a non-parametric Kruskal-Wallis test will analyze  
6  
7 continuous variables. A p-value lower than 0.05 will be considered significant. As this is an  
8  
9 exploratory study, the raw p-values will be reported along with corrections for multiple comparisons.  
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12 All statistics will be performed on SPSS or R software.  
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## 18 **DISCUSSION**

21 The MuSa study is a cross-sectional study that examines the risk variables associated with  
22  
23 student musicians' practice-related pain. The originality of this study lies in various factors related to  
24  
25 its conceptualization and target population. This project was co-constructed by scientists in the field  
26  
27 of health (Geneva School of Health Sciences, HEdS) and professional music teachers at the HEM,  
28  
29 which allows the protocol to be based on scientific knowledge and feedback from the field. This point  
30  
31 is critical for meeting the demands of the HEM and establishing effective health support for student  
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33 musicians. Free questions were drafted to meet this dual requirement, and validated questionnaires  
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35 were selected. Numerous pre-tests with HEM assistants and professors were conducted to ensure  
36  
37 the questions were understandable and interesting and to confirm the survey's feasibility. Another  
38  
39 original element in this study is its focus on the physical and mental risk factors associated with music  
40  
41 practice and work habits. The final multivariate statistical approach using network analysis may allow  
42  
43 the identification of intricate links between the multiple factors around health issues and the  
44  
45 detection of latent variables, potentially encompassing both physical and psychological factors. To  
46  
47 reduce bias, validated and music-specific questionnaires will be used. Moreover, all HEM students in  
48  
49 the curriculum will be contacted and informed of the study to obtain a maximum number of  
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51 participants studying various musical instruments.  
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57 This study provides a basis for developing numerous health promotion and pain prevention  
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59 approaches tailored to the context of student musicians. More specific research projects will be  
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3 developed based on the most relevant risk factors related to musicians' pain and latent factors based  
4  
5 on strongly associated variables. From a practical point of view, the implementation of preventive  
6  
7 and adapted actions will help develop students' health awareness, taking into consideration the  
8  
9 results of this study. The effectiveness of these actions can then be evaluated and will address the  
10  
11 lack of scientific knowledge on the effectiveness of preventive actions in student musicians'  
12  
13 curriculums. These perspectives should improve the students' mental, physical, and social health,  
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15 promoting learning in favorable conditions and leading to happier lives and more fulfilled careers.  
16  
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## 18 19 20 **ETHICS AND DISSEMINATION**

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22  
23 **Ethical committee:** Ethics approval has been granted by the Swiss Ethics Committee of the CCER  
24  
25 Geneva (2022-02206).  
26

27  
28 **Recruitment and consent:** Prospective, written consent will be obtained from all participants.  
29

30  
31 **Data collection, storage, and access:** Data will be de-identified and entered into a secure folder and  
32  
33 electronic database. Only the investigators and a statistician will have access to the final dataset.  
34

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36 **Dissemination strategy:** Outcomes will be disseminated through publication in peer-reviewed  
37  
38 journals, professional journals, and presentations at national and international conferences.  
39

## 40 41 **AUTHOR CONTRIBUTIONS**

42  
43  
44 All authors have contributed substantially to conception, design, drafting and revising of the article.

45  
46 All authors approved the final version.  
47

48  
49 CJ: conceived and designed the study, drafted and revised the manuscript; AS: participation in the  
50  
51 conception of the study and management of the REDCap platform ([https://www.project-](https://www.project-redcap.org/)  
52  
53 [redcap.org/](https://www.project-redcap.org/)); DAGD: management of the REDCap platform; AVB – as the study's principal investigator  
54  
55 – conceived and designed the study, funds raising, management of the project, drafted and revised  
56  
57 the manuscript.  
58  
59  
60

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## COMPETING INTEREST STATEMENT

None.

## Data availability statement:

Data supporting the findings of this study are available from the corresponding author [AVB], upon reasonable request.

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