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Original Paper

Simplified Medication Adherence Questionnaire (SMAQ) for People Living With HIV in a National Hospital in Mexico: Instrument Validation Study

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Abstract

Background: Adherence to antiretroviral therapy is a critical component in achieving viral suppression in people living with HIV in addition to increasing overall quality of life. Several indirect methods have been used to measure adherence including the Simplified Medication Adherence Questionnaire (SMAQ).

Objective: The objective of this study is to evaluate the reliability and validity of the SMAQ in men living with HIV/AIDS attending a Mexican national hospital.

Methods: A cross-sectional analytical design study was carried out in a Mexican National Hospital in Jalisco, including men aged >18 years with at least 3 months of antiretroviral treatment, excluding those with cognitive difficulties in answering the survey. A minimum sample size was calculated to detect the contribution of the variables within the model. The analysis included descriptive tests, confirmatory factor analysis, reliability and validity assessment, correlation between adherence and viral load, and association between viral load and adherence.

Results: The final analysis included a total of 260 patients with a mean age of 43 (SD 12) years and an average of 8.97 (SD 6.33) years on antiretroviral treatment. The SMAQ showed sufficient structural validity (comparative fit index=1, root-mean-square error of approximation=0, 90% CI 0-0.085) with satisfactory factor loadings on most questions except item 2 (Do you always take your medication at the prescribed time?). The reliability of the scale is acceptable (Cronbach α=0.702, ω=0.718). Adherence correlated with viral load significantly but not with recent TCD4 lymphocyte levels. Patients classified as adherent were three times more likely to be undetectable than nonadherent patients (odds ratio 3.31, 95% CI 1.13-9.64, *P*=.04).

Conclusions: The SMAQ represents an adequate tool to assess adherence in men living with HIV in the Mexican context, this will contribute to this study and compression of adherence to establish future intervention programs.

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KEYWORDS

treatment adherence; HIV; Mexico; validation; Spanish; Hispanic; cross sectional; surveys; questionnaires; scales; adherence; viral load; sexually transmitted infection; STI; drugs; pharmacotherapy; medication; simplified medication adherence questionnaire; SMAQ

Introduction

According to the Joint United Nations Program on HIV/AIDS, 39 million people were living with HIV by 2022, of which only 76.4% were receiving antiretroviral treatment (ART). In Mexico, by 2022, there were 270,000 cases registered with the Ministry of Health, 80% (n=270,000) of which were men; in addition, Jalisco ranks 4th in prevalence of people living with HIV with a record of 7134 patients on ART and 78% of this population has achieved viral suppression through such treatment [1,2].

The World Health Organization defines adherence to treatment as an individual's behavior regarding medications, diet, and lifestyle changes that correspond to the recommendations provided by a health professional [3].

Therapeutic adherence is a complex process that is made up of a personal component represented by the patient, where their attitudes toward their disease and the positions they take on it are concentrated, as well as a relational component involving the health professional and the health structure that surrounds them. All these components work synergistically toward a common goal to benefit the patient's health [4].

Adherence to ART is a critical component to achieve viral suppression in people living with HIV as well as to increase the overall quality of life [5]. Its study is important because in Mexico there has been a sustained prevalence in recent years, and it is necessary to improve the tools available to optimize treatment success [6].

There are various methods for measuring adherence in a patient; however, there is no gold standard for this purpose. Due to this, its measurement will depend on the characteristics of the population studied; in addition, the method should have basic psychometric standards of acceptable validity and reliability [7]. These methods are classified as direct, those that directly quantify the drug and its metabolites in blood or any other fluid or tissue, but they are costly and impractical for routine implementation, and indirect, that is they base their measurement on pill counts and self-reports, among others [8].

An indirect tool that has been used by several authors is the Simplified Medication Adherence Questionnaire (SMAQ). This questionnaire has been used in studies to evaluate adherence to ART in people living with HIV, and its six-question structure makes it practical in clinical contexts where a rapid evaluation is required [9,10]. This scale was introduced in 2002 by Knobel et al [9]. They designed the scale intending to create a questionnaire to identify nonadherent patients and found that this instrument had a sensitivity of 72%, a specificity of 91%, and a likelihood ratio of 7.94, as well as a Cronbach α of 0.75 [9].

The SMAQ questionnaire has also been validated in different pathologies, medical conditions, and chronic diseases, such as hypertension, diabetes, and tuberculosis. These validations have shown consistent results, supporting the usefulness and validity of the questionnaire in different health care settings [9,11]. The instrument was originally developed for the Spanish population in 1999, but the current social and pharmacological context differs for the population we are now studying. It is important to evaluate the validity and reliability of the instrument when used in contexts different from its original development, to ensure the quality of the collected information. This is because the metric quality of a self-report questionnaire must be explored in the context where it will be applied. Otherwise, the psychometric properties would be compromised, leading to negative consequences for the evaluation [12,13].

This questionnaire is not yet validated in Latin people, thus, its utility in our population is unknown. There is only a pilot study with 10 participants that used the SMAQ in Peruvian people living with HIV; where item comprehension was evaluated, as cultural applicability and social acceptance [14]. To our knowledge, no studies have been conducted to validate this instrument in the Mexican population. This study aimed to evaluate the reliability and validity of the SMAQ in people living with HIV/AIDS attending a Mexican national hospital.

Methods

Study Design

This study is a cross-sectional analytical design study concerning people living with HIV/AIDS receiving ART at the Civil Hospital of Guadalajara "Fray Antonio Alcalde."

Selection of Participants

Men older than 18 years of age receiving ART for at least three months before their inclusion in this study were included. Every participant gave his informed consent before participating in the research. On the other hand, those persons diagnosed with serious mental illnesses that may affect their ability to understand or answer the questionnaire were excluded, as well as those with cognitive or communication difficulties that may hinder their participation in the evaluation. Additionally considered as an exclusion criterion is not having performed the test to detect viral load within the period established for this study.

Sample Size Calculation

To determine the sample size, we used a calculator that used a structural equation model approach, in which we anticipated an effect size (factor loading) of 0.5, which would reflect a significant contribution of the latent construct to the observed variables (items), ensuring sufficient construct reliability, a power of 80%, one latent variable, five observable variables, and a probability level of 0.05, resulting in a minimum sample of 100 participants, to detect the specified effect given the structural complexity of this model [15,16].

Variables

The variables considered for this study were age in years, schooling (considered as the last completed grade of studies); municipality of residence (with the category "other" for those participants who indicated not being from a nearby municipality); marital status; employment (was considered positive when they would indicate having an economically remunerated activity); the use of tobacco, alcohol, and illicit drugs (it was considered positive when patients indicated to use in the last 30 days on more than two occasions); the number of pills (including those belonging to a treatment other than ART);

time living with HIV and time on ART (which were calculated considering from the date of HIV diagnosis and the start of ART until the date of enrollment in this study); and finally, clinical stage was classified according to the Center of Disease Control classification [17].

Instrument

The questionnaire consists of 6 questions: the first 4 can be answered with "yes" or "no," while the last 2 require numerical responses: "1. Do you ever forget to take your medication?" "2. Do you always take your medication at the prescribed time?" "3. Do you ever stop taking the drugs if you feel unwell?" "4. Did you forget to take the medication over the weekend?" "5. In the last week, how many times did you miss a dose?" and "6. In the last 3 months, how many full days did you miss taking the medication?" The six questions assess three components of ART adherence: (1) the intentional (question 3), (2) the unintentional (questions 1 and 2), and (3) frequency or quantity (questions 4, 5, and 6). The patient is classified as nonadherent if they answer any in a "nonadherence sense" and if they report missing more than two doses in the last week or reports not having taken more than 2 full days of medication in the last three months [10].

Statistical Analysis

For descriptive analysis, normality tests were performed as necessary. Quantitative variables were described with means or medians, and qualitative variables with frequencies and percentages.

The evidence of validity based on internal structure. was assessed by confirmatory factor analysis using the weighted least squares method with adjusted mean and variance [18]. Model fit was assessed using recognized indices, such as comparative fit index (CFI>0.90) [19], root-mean-square error of approximation (RMSEA<0.08) [20], and weight root-mean-square residual (WRMR<1) [21].

To determine reliability, we estimated the internal consistency coefficients according to Ponterotto and Charter [22]. Scores Cronbach α>0.70 were considered as reliable scores [22]. In addition, we investigated validity by examining the relationship between adherence and undetectable plasmatic viral load using the Pearson correlation coefficient [23].

Finally, Fisher exact tests were used to calculate the odds ratios (OR) to evaluate the association between having an undetectable (patient in control) versus detectable (patient not in control) plasmatic viral load and the scale classification of adherent versus nonadherent (based on the concept that a patient with an undetectable viral load was an adherent patient) [5].

The descriptive and correlational analyses were carried out in SPSS (version 24; IBM Corp) software, while the factor analysis was performed with Mplus (version 7; Muthén & Muthén) software [19]. Finally, the analysis of ORs was performed in Epi Info (Centers for Disease Control and Prevention) software in the Stat Cal module [24].

Ethical Considerations

This research was approved by the Bioethics Committee of the Civil Hospital of Guadalajara (169/23), and it was carried out under the ethical standards for research on human participants. All participants signed an informed consent form that outlined the objectives of the research, the procedures to be followed, and the contact information for the research team. Any questions or concerns were addressed verbally prior to signing the consent form. The information collected was handled exclusively by the research team, and to protect participants' identities an alphanumeric code was assigned to each. Additionally, identifying data were excluded from the database used for analysis. Finally, no direct financial compensation was provided to participants for their involvement in the study.

Results

Characteristics of the Participants

A total of 299 patients were evaluated, 259 men and 40 women, and due to the ratio between groups, we decided to exclude the group of women from the analysis, to maintain the homogeneity and representativeness of the sample [25].

Of the 259 participants included, the mean age was 43 (SD 12) years with an average of 8.97 (SD 6.33) years in ART treatment. Considering schooling, the majority had high school (n=87, 34.6%) or middle school (n=57, 22%) education. The most common municipality of residence was Guadalajara (n=110, 42.5%) and the vast majority were single (n=214, 82.6%). Regarding substance use, 89.6% (n=232) had not consumed illicit substances in the last 30 days while 33.6% (n=87) had consumed alcohol and tobacco in the same period. The mean number of pills per day was 2 (SD 2) and the mean number of years living with HIV was 10 (SD 7.17) with an average CD4+ T lymphocyte count of 686.5 cells/µL (SD 353.88; Table 1).

Table 1. Sociodemographic characteristics of the sample (N=259).

	Values
Age (years), mean (SD)	43 (12)
Schooling, n (%)	
Illiterate	2 (0.77)
Can read and write	16 (6.2)
Primary school	44 (17)
Junior high school	57 (22)
High school	87 (34.6)
University	50 (19.3)
Postgraduate	3 (1.2)
Municipality of residence, n (%)	
Guadalajara	110 (42.5)
Zapopan	32 (12.4)
Tlaquepaque	24 (9.3)
Tonalá	16 (6.2)
Zapotlanejo	2 (0.8)
Tepatitlán	1 (0.4)
La Barca	1 (0.4)
Arandas	2 (0.8)
Zapotlán el Grande	2 (0.8)
Other	69 (26.7)
Marital status, n (%)	
Single	214 (82.6)
Married	16 (6.2)
Common law marriage	22 (8.5)
Widower	2 (0.8)
Regular employment, n (%)	
No	37 (14.3)
Yes	222 (85.7)
Used any illicit substance within the last 30 days, n (%)	
No	232 (89.6)
Yes	27 (10.4)
Consumed alcohol in the last 30 days, n (%)	
No	172 (66.4)
Yes	87 (31.3)
Used tobacco in the last 30 days	
No, n (%)	171 (66)
Yes, n (%)	87 (33.6)
Pills taken per day, mean (SD)	2 (2)
Years in ART[a], mean (SD)	8.97 (6.33)
Years living with HIV, mean (SD)	10.08 (7.17)
CD4+ T lymphocyte count, mean (SD)	686.47 (353.88)

	Values
Clinical stage according to the CDC[b], n (%)	
A1	122 (47.1)
A2	20 (7.7)
A3	4 (1.4)
B1	16 (6.2)
B2	4 (1.5)
B3	4 (1.5)
C1	37 (14.3)
C2	32 (12.4)
C3	20 (7.7)

[a]ART: antiretroviral therapy.

[b]CDC: Centers for Disease Control and Prevention.

Responses From the Participants

Regarding the responses to the questionnaire, 66.6% (n=172) of the respondents reported not forgetting their medication, while 33.4% (n=87) admitted to having forgotten it at least once. On the second question, 80.3% (n=198) stated that they took their medication at the indicated time and 19.7% (n=61) admitted not following this pattern. Regarding whether they stopped taking the drugs if they felt unwell, the great majority (n=242, 92.2%) stated that they did not do so but 7.8% (n=17) admitted having done so at some time.

The majority reported not having forgotten to take their medication over the weekend (n=250, 96.6%). In the last week, the majority (n=242, 93.8%) reported missing only one dose, while 6.2% admitted missing a dose once or twice.

On the other hand, of the responses to question 6, a total of 66.5% (n=174) indicated not having missed taking medication on any full day, while 30.6% (n=174) acknowledged having experienced some degree of medication interruption.

Finally, according to the scores of the questionnaire, 66.6% (n=174) of participants reported being adherent while 33.4% (n=88) reported being nonadherent (Table 2).

Table 2. Distribution of responses to the Simplified Medication Adherence Questionnaire (N=259).

Questions	Participants, n (%)
1. Do you ever forget to take your medication?	
No	172 (66.6)
Yes	87 (33.4)
2. Do you always take your medication at the prescribed time?	
No	61 (19.7)
Yes	198 (80.3)
3. Do you ever stop taking the drugs if you feel unwell?	
No	242 (92.2)
Yes	17 (7.8)
4. Did you forget to take your medication over the weekend?	
No	250 (96.6)
Yes	9 (3.4)
5. In the last week, how many times did you not take a dose?	
1	242 (93.8)
2	16 (5.9)
3	1 (0.3)
6. In the last 3 months, how many full days did you not take your medication?	
0	174 (66.5)
1	51 (20.6)
2	17 (5.9)
3	7 (3.1)
>4	10 (1)
Outcome on adherence	
Adherent	174 (66.6)
Nonadherent	88 (33.4)

Evidence of Validity Based on Internal Structure

The unidimensional model obtained favorable fit indices (CFI=1; RMSEA=0, 90% CI 0-0.085; WRMR=0.072), as well as factor loadings around what was expected, except for item 2 (Do you always take your medication at the prescribed time? Table 3). After performing a second analysis without item 2, the results are adequate both at the level of fit indices (CFI=1; RMSEA=0, 90% CI 0-0.103; WRMR=0.047) and factor loadings (>0.50; Table 3).

Regarding reliability, the magnitudes were acceptable for both scores (Cronbach α=0.702) and construct (ω=0.718).

Finally, the correlation of adherence with viral load was statistically significant (r=0.128; P=.04), but not with recent CD4 T lymphocyte counts (r=0.015; P=.81).

On the relationship between undetectable viral load and adherence, those patients classified as adherent by the scale were 3 times more likely to be undetectable compared to those classified as nonadherent (OR 3.31, 95% CI 1.13-9.64, P=.04; Table 4).

Table 3. Factor loadings of the Simplified Medication Adherence Questionnaire scale.

Questions	First analysis	Second analysis
1. Do you ever forget to take your medication?	0.815	0.854
2. Do you always take your medication at the prescribed time?	–0.358	—[a]
3. Do you ever stop taking drugs if you feel sick or drink alcohol?	0.612	0.526
4. Did you forget to take your medication over the weekend?	0.383	0.374
5. In the last week, how many times did you not take a dose?	0.677	0.701

[a]Not applicable.

Table 4. Relationship between Simplified Medication Adherence Questionnaire adherence classification and viral load.

	Adherent	Nonadherent	OR[a] (95% CI)	*P* value
Undetectable viral load[b]	168	76	3.31 (1.13-9.64)	.04
Detectable viral load[c]	6	9	—[d]	—

[a]OR: odds ratio.

[b]Plasma viral load of ≤40 copies/mL.

[c]Plasma viral load >40 copies/mL.

[d]Not applicable.

Discussion

Principal Findings

Adherence is vital to achieve viral suppression and increase the quality of life of people living with HIV; however, its measurement represents a major challenge [26]. Although direct methods exist to measure adherence (eg, plasma drug concentration), they are costly and impractical for routine implementation in clinical settings with limited resources such as ours [8], thus, indirect measurement methods based on self-reporting may have a good performance and could be used routinely.

This study aimed to evaluate the reliability and validity of the SMAQ in people living with HIV/AIDS attending a public hospital in the western region of Mexico.

As for the factorial structure, 4 of the 5 original items were retained, and the one that was eliminated obtained the lowest factorial loading, and its response was oriented in the opposite direction to the other items, which reinforces the argument that this type of item usually presents methodological problems. This new four-item version obtained adequate fit and reliability indices (CFI=1; RMSEA=0, 90% CI 0-0.103; WRMR=0.047) [27].

The validity of its relationship with other variables was analyzed using an association with viral suppression (or undetectable viral load), finding a threefold greater probability of achieving viral suppression when classified as adherent (OR 3.31, 95% CI 1.13-9.64, *P*=.04).

The use of the SMAQ in the framework of explanatory studies could provide greater insight into the factors associated with adherence, providing evidence for the design of appropriate interventions to improve adherence in this patient population [28]. This, in turn, would strengthen the capacity of health services to enhance and promote quality care, ultimately yielding a positive long-term impact on people living with HIV.

Concerning previous studies, the study by Agala et al [10] also found adequate factor loadings, except for one item, like this work. However, there is no agreement on the eliminated item, which could be attributed to differences in the populations studied because the analysis of our study was only in men and theirs in women. This highlights the existing differences in adherence behaviors between these groups [10].

This situation underscores the need to consider sociodemographic and cultural characteristics when analyzing the evidence and validity of self-report tools such as the SMAQ.

Limitations

Regarding its limitations, it is important to recognize that, despite its simplicity, it may be subject to self-report bias [11]. Similarly, only men were considered due to the proportion that was recruited from both groups and to maintain statistical homogeneity [29]. This limitation does not allow for the opportunity to explore differences that could influence adherence between the two groups.

It is concluded that the SMAQ presents favorable evidence of validity per internal structure and association with viral suppression, as well as acceptable levels of reliability.

In future studies, we recommend that the SMAQ be analyzed at a psychometric level in the group of women to explore possible differences by gender. In addition, this tool will allow studies focused on adherence and its determinants to be carried out with a greater degree of precision.

Conclusions

The use of the SMAQ provides a valuable tool for assessing adherence among the Mexican population living with HIV. This evaluation is critical for enhancing health outcomes and

optimizing therapeutic interventions. Additionally, the SMAQ helps to strengthen public health programs by furnishing reliable data on treatment adherence, which can inform the development of targeted strategies to support patient engagement and medication management.

Acknowledgments

LEDMT contributed to the conception of the idea, the development of the protocol, analysis of results, and conclusions. LAGH worked on the development of the protocol, processing of results, and writing of this paper. JFAV did the writing of the discussion and the final review. PM-A, AVR, and VVRH selected and recruited participants. JAVR carried out the analysis of results and the development of the protocol. MGHG assisted in the general review of the document and the preparation of the final version. SD-L helped with the analysis of the scale, statistical analysis, and writing of the results.

Conflicts of Interest

None declared.

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Abbreviations

ART: antiretroviral treatment
CFI: comparative fit index
OR: odds ratio
RMSEA: root-mean-square error of approximation
SMAQ: Simplified Medication Adherence Questionnaire
WRMR: weight root-mean-square residual

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Original Paper

Interstep Variations of Stairways and Associations of High-Contrast Striping and Fall-Related Events: Observational Study

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Abstract

Background: Interstep variations in step riser height and tread depth within a stairway could negatively impact safe stair negotiation by decreasing step riser height predictability and, consequently, increasing stair users' fall risk. Unfortunately, interstep variations in riser height and depth are common, particularly in older stairways, but its impact may be lessened by highlighting steps' edges using a high-contrast stripe on the top front edge of each step.

Objective: This study aimed to determine (1) if fall-related events are associated with greater interstep riser height and depth variations and (2) if such fall-related events are reduced in the presence of contrast-enhanced step edges compared with a control stairway.

Methods: Stair users were video recorded on 2 public stairways in a university building. One stairway had black vinyl stripes applied to the step's edges and black-and-white vertical stripes on the last and top steps' faces. The stairway with striping was counterbalanced, with the striped stairway than a control, and the control with stripes. Each stair user recorded was coded for whether they experienced a fall-related event. A total of 10,000 samples (observations) of 20 fall-related events were drawn with 0.25 probability from each condition to determine the probability of observing a distribution with the constraints outlined by the hypotheses by a computerized Monte Carlo simulation.

Results: In total, 11,137 individual stair user observations had 20 fall-related events. The flights that had 14 mm in interstep riser height variation and 38 mm in interstep depth variation were associated with 80% (16/20) of the fall-related events observed. Furthermore, 2 fall-related events were observed for low interstep variation with no striping, and 2 fall-related events were observed during low interstep variation with striping. A total of 20 fall-related events were observed, with 4 occurring on flights of stairs with low interstep variation. For stairs with high variability in step dimensions, 13 of 16 (81%) fall-related events occurred on the control stairway (no striping) compared with 3 of 16 (19%) on the high-contrast striping stairway. The distribution of fall-related events we observed between conditions likely did not occur by chance, with a probability of 0.04.

Conclusions: These data support the premise that a vision-based strategy (ie, striping) may counteract fall risk associated with interstep riser height and tread depth variation. Possibly, perception and action elicited through the horizontal-vertical illusion (striping) may have a positive impact on the incidence of fall-related events in the presence of high interstep riser height and depth variation. The findings of this study suggest that contrast enhancement (ie, striping) may be a simple and effective way to reduce the risk of falls associated with interstep variation, highlighting the potential for this approach to make a significant impact on fall prevention efforts.

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KEYWORDS

stairs; stairway safety; riser height; tread depth; horizontal-vertical illusion; fall risk; fall prevention; videos; Monte Carlo simulation; public health; vision-based strategy; health promotion; adults; geriatric

Introduction

When approaching a stairway, stair users seemingly anticipate uniformity in the step riser height and tread depth [1,2]. However, this assumption may lead to fewer attentional resources being allocated to estimating these metrics, potentially compromising the safe negotiation of the stairway. Unfortunately, interstep riser height and tread depth variations are common. Often described as dimensional uniformity in building code, stair riser heights and tread depths shall be of uniform size and shape. The tolerance between the largest and smallest riser height, or tread depth, shall not exceed 3/8 inch in any flight of stairs. In our investigation, the range of dimension uniformity is referred to as interstep variation. Interstep variations, as small as 6 mm, between adjacent stair risers or treads can disrupt step cadence and increase the risk of accidents or falls [3]. One strategy to mitigate this risk involves applying a horizontal-vertical illusion and black stripes to the top front edge of each step, which could potentially decrease the frequency of slips, trips, and falls [4-6]. Recent research has demonstrated that adding a high-contrast stripe along the top front edge of each step [4,7-11] can lead to increases in heel clearance above the step. Similarly, adding vertical monochrome striping to the faces of the bottom and top steps can also enhance vertical foot clearance [4,5,12,13].

Although the exact mechanism behind these interventions is not fully understood, it is possible that they increase step height by drawing more attention to each step's edge [7] or by creating a horizontal-vertical illusion, which makes the steps appear taller than they actually are [14,15]. Ultimately, either mechanism may decrease the likelihood of a slip, trip, or fall on stairs with high interstep variation. We, therefore, hypothesized that when comparing 2 flights of stairs with similar interstep variability, the stairs with vertical monochrome striping and tread edge highlighters would record fewer fall-related events than stairs without this intervention. In addition, stairs with greater interstep variation in riser heights and tread depths would generally record more fall-related events than stairs with less interstep riser height and tread depth variability, but this effect would be lessened with the addition of monochrome striping and tread edge highlighters.

To test our hypotheses, we estimated the probability of observing a range of fall-related event distributions that could plausibly occur by chance, given our hypotheses [high or low interstep riser height and tread depth variations and control or striping intervention conditions]. We codified our hypotheses in a Monte Carlo simulation using 4 constraints based on our hypotheses. First, there would be more fall-related events on control flights of stairs (without the contrast intervention) with greater interstep variation than those with lower interstep variation. Second, both control and intervention (with the contrast enhancement) flights of stairs with low interstep variation should observe a comparable frequency of fall-related events (ie, a difference of less than 2 fall-related events between conditions). Third, fewer (less than or equal to half the number of) fall-related events should be observed with high interstep variation intervention stairs compared with the high interstep variation control stairs. Finally, the relative difference in fall-related events between high and low interstep variation stair flights in the control condition should be greater than on the intervention flights.

Methods

Participants

This cross-sectional study took place on 2 public stairways on the Utah State University campus. Video capture occurred on public stairways, and most stair users appeared to be young adults.

As previously discussed, 11,137 individual stair user observations were coded and balanced across the stairway conditions (control and intervention) and stairways (East and West) [16]. There were 7458 (66.97%) feminine observations and 3679 (33.03%) masculine observations, where most observations (n=10,970, 98.5%) were in the age group of 18-40 years. Additional participant details were described previously [6]. Given the observational nature of this study in a public space, no screening was performed in advance. Eligibility criteria were as follows: (1) inclusion—visually appearing 18 years of age and older, captured within local time (eg, 7 AM-5 PM) and (2) exclusion—use of assistive walking devices (eg, crutches and walking boots), individuals that did not transverse the stairs, or involved unusual stairway behavior, as described by Harper et al [6] were documented and removed during the data cleaning phase.

Protocol

High-resolution security cameras (8 megapixels, 4K Ultra HD, 3840×2160 resolution at 7 frames per second, Lorex cameras [Lorex Technology Inc]) were placed in the stairways to record stair users' behavior.

Intervention

High-contrast black vinyl film (Gerber High-Performance Series 220 vinyl film [Gerber Technology]) stripes (5.5 cm wide, 0.063-0.09 mm thick) were applied flush to the top front edge of each stair [4,9,12]. A total of 19 black-and-white vertical vinyl stripes (12 cycles/1 meter) were placed on the very bottom and top steps' faces [4,9,12].

Figure 1 [6] depicts the combined striping intervention. Stairway interstep riser height and depth variations were measured across every step, from the middle part of the step (Figure 2) [6].

Figure 1. Control and interventional stairway conditions. Intervention conditions are further illustrated to show step riser (face of step) and top of step (superior view) vinyl stripes. Step riser height=step height. Stairway width=step tread depth. Vinyl striping depth. Adapted from Harper et al [6], which is published under Creative Commons Attribution 4.0 International License [17].

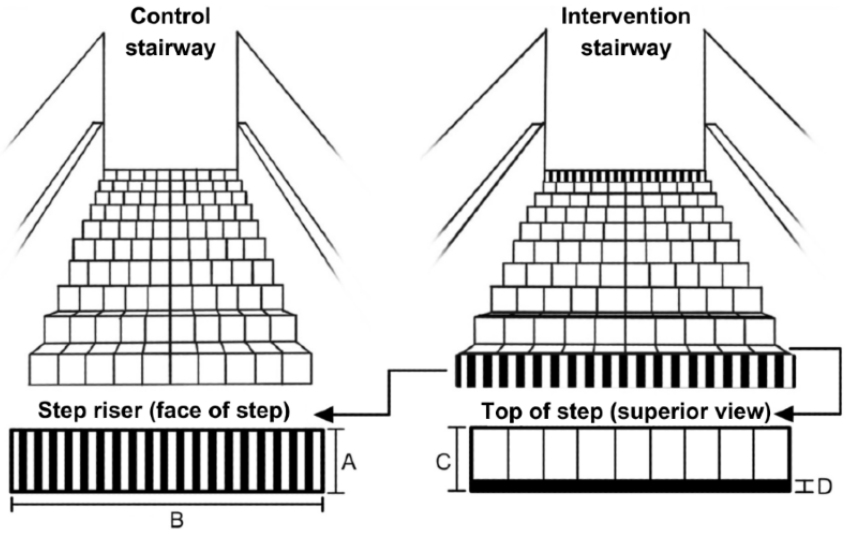
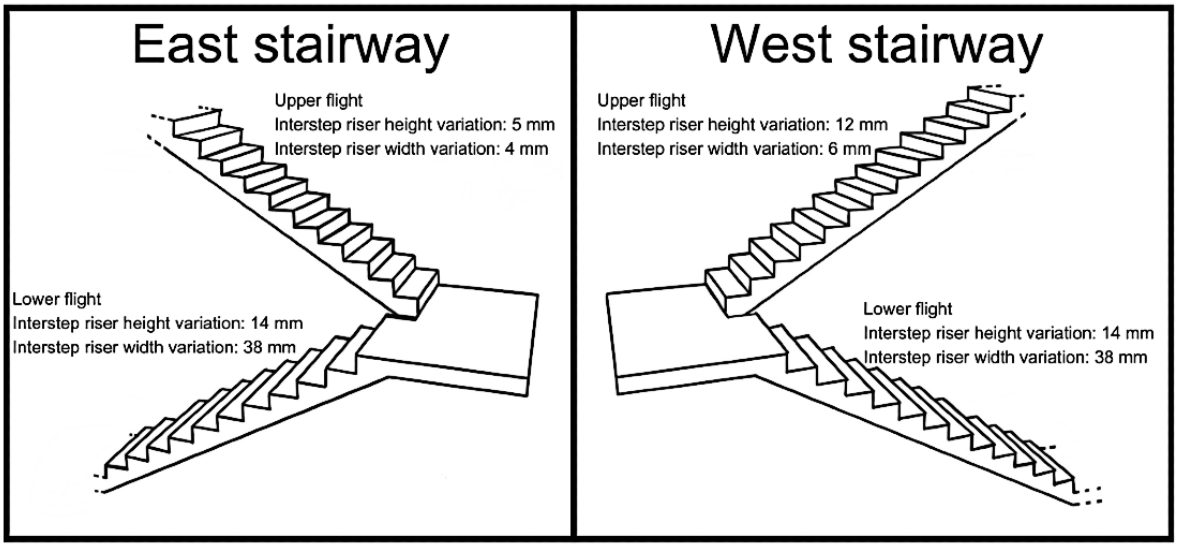


Figure 2. Real-world stairway design. East upper and lower stairway flights interstep riser height variation ranged between 5 mm and 14 mm, and interstep depth between 4 mm and 38 mm, respectively [6]. West upper and lower stairway flights' interstep riser height variation ranged between 12 mm and 14 mm, as well as interstep tread depth variation of 6 mm and 38 mm respectively, are shown [6]. Adapted from Harper et al [6], which is published under Creative Commons Attribution 4.0 International License [17].



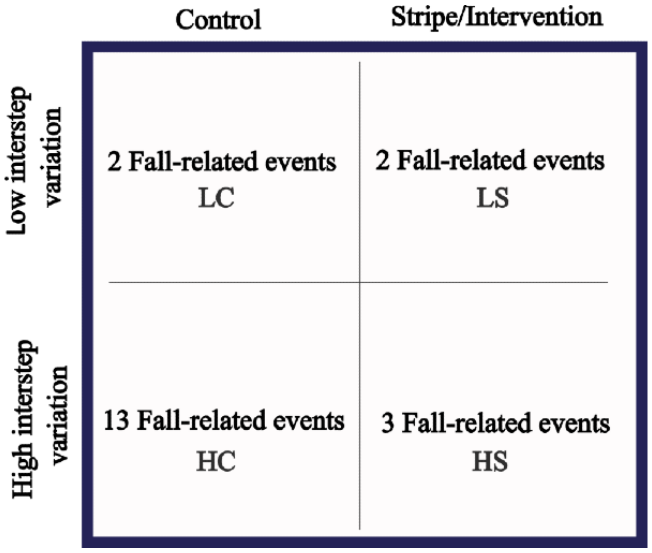
In total, 48 steps were observed across 4 flights of stairs. The control stairway was unaltered and used to compare with the intervention stairway. Halfway through data collection, the intervention (striped) and control stairways were counterbalanced.

Measures

Each outcome variable was assessed by stairway location (East and West) and condition (intervention and control), as well as by stairway flight (lower and upper; Figure 3).

In total, 4 assumptions were used to code our hypotheses based on our a priori knowledge of the total number of fall-related events recorded (n=20): (1) the number of fall-related events high interstep variations, control condition>low interstep variations, control condition; (2) the difference between low interstep variations, stripe intervention and low interstep variations, control condition ≤2 fall-related events; (3) the number of falls in high interstep variations, control condition will be ≥2 times of high interstep variations stripe intervention; and (4) the difference between low interstep variations, control condition and high interstep variations, control condition > the difference between low interstep variations, stripe intervention and high interstep variations stripe intervention. The probability of a distribution meeting these assumptions occurring by chance is approximately 0.04 with a sample size of 20.

Figure 3. The probability of observing a range of distributions of fall-related events. The following assumptions evaluated the observed fall-related event distribution. HC: high interstep variations, control condition; HS: high interstep variations stripe intervention; LC: low interstep variations, control condition; LS: low interstep variations, stripe intervention.



Data Sources

We coded stair users' navigation direction (ascent and descent) and the presence of a fall-related event. As described previously, a fall-related event was coded if an observed stair user experienced a relatively subtle trip or slip, with minimal recovery action, through a complete loss in balance, resulting in a fall [6]. If a fall-related event occurred, the stairway and step number (starting from the bottom to the top) were recorded. To assess research bias or intercoder reliability, each week, one of the researchers would randomly select and evaluate 10% of the data collected for that week. If an error was present, a second coder reviewed all data recorded by the first coder for the week in question, and the second coder made a determination on the final coding record [6]. Data were encoded using Microsoft Excel.

Statistical Analysis

Data are presented as mean (SD) as well as count (percentage) of observed results. The distribution of fall-related events was assessed across stairway flights (interstep variations) and conditions (control and intervention) using a 0.5-inch threshold (approximately 13 mm), given that 75% (80/101) of stair accidents occurred in stairways with interstep riser height variations of ≥0.5 inch [18]. A Monte Carlo simulation in Julia [19] was used to estimate the probability of observing the distribution of fall-related events defined by our hypotheses by chance. Specifically, 10,000 samples (observations) of 20 fall-related events (refer to the Results section) were drawn with 0.25 probability from each condition to determine the probability of observing a distribution with the constraints outlined by the hypotheses through a computerized Monte Carlo simulation [20,21].

Ethical Considerations

Ethical approval was obtained from the institutional review board of Utah State University (10773). As an observational study, participants did not give written consent. Given the observational nature, participants were not compensated to participate. The video recordings were taken in a public setting, and only the approved research team had access to the identifiable data. Therefore, our video data are not available as supplementary material.

Results

Individuals who had any visible health-related conditions (eg, crutches and walking boots) were documented and removed before analysis. In addition, those who visually appeared under the age of 18 years were documented and removed before analysis. All steps were measured at the center of the steps. The average of the East and West stairways combined was 168 (SD 4) mm, with the average riser height of the West stairway steps being 171 (SD 3) mm, and the East stairway being 166 (SD 3) mm, independently. The average step tread depth for the East and West stairways was 328 (SD 8) mm, the average depth of the West stairway steps was 327 (SD 8) mm and the Easy stairway was 329 (SD 8) mm.

Of 20 observed fall-related events, 80% (n=16) of events were observed on the flights where interstep variations were the greatest (riser height ranged 14 mm and tread depth ranged 38 mm). In comparison, 4 of 20 fall-related events were observed on flights with lower interstep variation. Between East and West stairways, 7 of 20 (35%) fall-related events occurred on steps that had step riser heights greater than 1 SD from their mean including 2 fall-related events that occurred on the first step while ascending (step riser height=170 mm; flight mean 166, SD 3 mm), 3 events on the last step while descending the East, lower stairway (height=155 mm; mean 166, SD 3 mm), 1 event on the last step while ascending the East, upper stairway (height=170 mm; mean 166, SD 3 mm), and 1 event on the second-to-last step while ascending the West, lower stairway (height=173 mm; mean 171, SD 4 mm).

A total of 20 fall-related events were recorded. On flights where interstep riser height variation ranged 14 mm and step depth variation ranged 38 mm, 13 of 16 (81%) fall-related events occurred on the control stairway condition (no striping),

compared with 3 of 16 (19%) on the striped intervention stairway. Finally, 2 fall-related events were observed for low interstep variation with no striping, and 2 fall-related events were observed during low interstep variation with striping.

The estimated probability of observing data that fit the range of distributions constrained by our hypotheses and using a sample size of 20 fall-related events, was approximately 0.04 (Figure 3). This result suggests that (1) interstep variations may be contributing to falls and (2) adding a striping intervention to the stairs may reduce the impact of interstep variations on fall-related events.

Discussion

Principal Results

We sought to assess the impact of interstep riser height and tread depth variations on fall-related events (eg, slips, trips, or falls) occurring on stairways to determine if fall risk increases with greater interstep variations but is reduced by adding high-contrast striping. The lower flights of stairs, which had interstep riser height variations that ranged 14 mm and interstep depth variations that ranged 38 mm, accounted for 80% (16/20) of the observed fall-related events, supporting the notion that stairways with greater interstep variations may be associated with a greater risk of fall-related events. Furthermore, 35% (7/20) of fall-related events were observed on steps where interstep riser height variation was greater than 1 SD from the flight mean. Together, these results suggest that flights of stairs with greater interstep riser height variation exhibit more fall-related events than flights with lower interstep variation. When high-contrast striping was added to flights of stairs with high interstep variation, there were fewer fall-related events observed over a similar time period (3/20 fall-related events in the intervention vs 13/20 fall-related events in the control condition). This result suggests the addition of high-contrast striping to stair flights with high interstep variation may reduce the number of fall-related events resulting from interstep variation.

Comparison With Previous Work

Interstep Variations Increase Fall Risk

Interstep variations on stairways can have a profound negative impact on fall risk. Even minor interstep variations, such as a 6 mm variance in riser height [3], can disrupt step cadence and increase the likelihood of a fall, as can interstep variation in tread depth. Furthermore, a review of 80 stairway falls from 1992 to 2007 found that 60% (48/80) of riser height and 34% (27/80) of interstep depth variation were greater than 3/8 inch in a study by Cohen et al [7], and greater (3/8 inch compared with 0.5 inch) interstep variation that can disrupt cadence [3]. Francksen et al [22] found that adults could adjust their stepping behavior for increases in depth, but they could not adjust for interstep riser height variation over 10 mm. Stair-related fall injuries are also more commonly associated with interstep riser height variation than interstep tread depth variation [7]. Alternatively, the greater association of falls with interstep riser height variation could be due to the increased frequency of observing interstep riser heights compared with tread depth variations (eg, > 3/8 inch is observed more often in riser heights [48/80, 60%] than tread depths [27/80, 34%]) [7]. Nevertheless, additional research is needed to explore the extent and impact of interstep variation on stair-related falls. In this study, we observed that 80% (16/20) of fall-related events on stairs occurred when the interstep riser height variation was 14 mm and depth was 38 mm. Since interstep riser height and depth variations were both present in our observational design, we are unable to distinguish which of these factors may have had a greater role.

The Intervention Was Associated With Reduced Fall-Related Events With Interstep Variation

Broadly, our findings indicate that greater interstep variations are associated with an increased frequency of fall-related events. Importantly, the frequency of these fall-related events decreased when the intervention was present. Our data suggest that adding high-contrast stripes may reduce fall-related events on stairs when large interstep variations are present. Of the 20 fall-related events observed, 16 were on the flights of stairs with larger interstep variation, but only 19% (3/16) occurred when the intervention was present, whereas 81% (13/16) occurred when the intervention was absent.

Mechanisms Contributing to the Reduction in Fall-Related Events

The intervention may induce a horizontal-vertical illusion by the intervention. This occurs when horizontal and vertical lines of similar length are presented together (like the letter “T”), which results in an illusory sense that the vertical line is longer than the horizontal one. The intervention used in this study included black vinyl stripes applied to each step’s top front edge and black-and-white vertical stripes on the face of the first and last steps. Together, the abutting edges of the combined striping that formed “T”-like configurations could have contributed to an increased perceived step riser height [14], resulting in greater step heights. Indeed, previous research suggests that under similar experimental conditions, perceived step height is increased and is associated with an increase in the height of the step taken [12,13,15]. In further support for this mechanism, the horizontal-vertical illusion effect is reduced when only edge highlighters are present [13], suggesting that the vertical lines contribute to the increased step height and, perhaps, that the horizontal-vertical illusion is a primary mechanism contributing to the reduction in fall-related events we observed with the intervention. It is also possible that other intervention formats, such as those that could induce the Müller-Lyer illusion [23], could reduce fall-related events. The Müller-Lyer illusion occurs when the perceived length of a line is influenced by the orientation of arrow-like segments attached to its ends. Lines of the same length appear shorter or longer depending on whether the arrowheads at the ends point inward or outward. By manipulating the direction of the fins at the end of the lines, perhaps step height could be increased or decreased depending on the particular interstep variation. Recent outdoor observational research suggests that greater vertical foot clearance occurs when a “fins out” configuration is applied to a 2-step stairway [24], which is the illusion’s expected effect.

Future research could examine whether a "fins in" configuration reduces step height.

By accentuating the steps' edges, the intervention may draw attention to them, thereby enhancing the accuracy with which stair users can estimate the dimensions of each step and then compensate for irregularities. Future research could investigate whether the presence of striping increases awareness of interstep variation, thereby evaluating this potential mechanism. In addition, the novelty of the intervention itself may have drawn attention to the stairs. Schomaker and Meeter [25] suggest that novel visual stimuli, such as a change in contrast, may increase attention to the stairs [26]. It is worth noting that the striping intervention was installed several days before data collection began. It is likely that some stair users had exposure to the striping before the start of video recording and this early exposure could have reduced the novelty of the striping effect before data collection, thus reducing the drawing effect. We also expect that this effect would have worn off over time as many of the observed stair users traverse the stairs frequently due to regular classes in the building.

What Should Be Done About Excessive Interstep Variations

Maybe the most important challenge associated with observing increased fall-related events with greater interstep variations is what to do about it. Is the risk of falls sufficient to warrant widespread evaluation and enforcement of building codes? Although we do not provide recommendations here, conducting assessments, enforcing regulations during construction, and evaluating older stairways (likely to exhibit the greatest interstep variation) may reduce fall-related events, especially when considering cost-effectiveness. For older stairways, as used in this study (built in 1971, and at the time of construction, the 1967 Uniform Building Code [Sec 3305 (d)] that was in place in the United States required the maximum interstep variation in riser height and tread depth to be no more than 3/16 inch), adding an intervention like painting stripes might be the most cost-effective way (an estimated US $288 for the high-contrast striping used here) to reduce the impact of interstep variations (assuming the application or materials used to apply the striping do not themselves increase fall risk through reduced or increased friction, or materials peeling). While increased interstep variation is associated with a greater risk of fall-related events, there are cost-effective interventions that can help reduce this risk. By enforcing building codes and evaluating stairways for interstep variation, we can work toward creating safer environments for everyone.

Limitations

While these results are promising, we acknowledge several limitations of this study. Even with over 10,000 observations, we only observed 20 fall-related events. A larger sample of falls would provide a more precise estimate of the differences between flights of stairs and strengthen the inferences that could be drawn from these data. Since most of the observations in this study were younger adults, future work should consider targeting older or clinical populations (eg, those with visual impairment and mobility-related limitations) to determine if such an intervention could reduce fall-related events. However, future designs will need to consider comparing historical fall frequency records to future intervention fall frequencies rather than using a control condition if it could pose a fall risk to these populations. Furthermore, we did not include Cohen κ, as a measure of interrater reliability. In addition, the lack of a validated questionnaire, such as Yang et al [27], are methodical limitations and should be included in future studies. In addition, given the emphasis on younger adults in this study, it is unknown whether the striping intervention's impact is greater in younger versus older adults. Finally, since the steps used here had interstep variations in both riser heights and tread depths, future observational designs could assess these 2 factors independently to determine the impact of each on fall risk.

Future Directions

Given the considerable negative impact of falls on public health, continued research is necessary to improve safety on stairways. In addition, programs, such as educational campaigns, could be used to raise awareness of factors that contribute to falls [28] and perhaps to help motivate small actions, such as painting stripes on problematic stairways that could have a big impact on public health and provides support for scaling up effective public health interventions for long-term population health benefits.

Conclusions

This study highlights the importance of addressing interstep variations in stairways to reduce the risk of fall-related events. By understanding the factors that contribute to fall risk and implementing cost-effective interventions, we can work toward creating safer environments for everyone. The findings of this study suggest that contrast enhancement (ie, striping) may be a simple and effective way to reduce the risk of falls associated with interstep variations, highlighting the potential for this approach to make a significant impact on fall prevention efforts.

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Data Availability

The datasets generated during and/or analyzed during this study are not publicly available since the video data are not deidentified.

Conflicts of Interest

None declared.

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Original Paper

Student and Physician Views of How the Dobbs Decision Affects Training and Practice Location Preferences: Cross-Sectional Questionnaire Study

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Abstract

Background: By allowing for abortion bans and restrictions to take effect in the majority of US states, the 2022 *Dobbs v Jackson Women's Health Organization* decision portends to have lasting impacts on patient care and the physician workforce. Notably, it is already beginning to impact practice location preferences of US health care workers, evidenced by declining application rates to residency programs in abortion-restrictive states since 2022. Yet, there remains a gap in the literature regarding why this trend exists.

Objective: This study aims to describe what factors are driving the practice location preferences of medical students and physicians after the *Dobbs* decision.

Methods: This study analyzes qualitative data from a web-based, cross-sectional study. In August 2022, a nonprobabilistic sample of physicians and medical students were surveyed on social media about the impact of overturning *Roe v Wade* on practice location preferences, which included the free-text question "Please share your thoughts about the overturning of *Roe v Wade* and how it will affect your decision about your (residency/job or fellowship) programs." A total of 3 independent team members completed an inductive thematic analysis of 524 free responses, resolving differences by discussion.

Results: Approximately 1 in 4 survey respondents also completed the free-response item (524/2063, 25.4%); a total of 219 were medical students, 129 were residents and fellows, and 176 were practicing physicians. Of them, approximately half (261/524, 50.5%) resided in states where abortion bans were in place or anticipated. Those who answered the free-response item were relatively more likely to hail from states with restrictive abortion bans (P<.001) compared to those who did not, with other demographic characteristics being largely similar between the groups. Inductive thematic analysis yielded 2 broad thematic categories: patient-related and workforce-related factors influencing practice decision preferences. The 3 most common themes overall were respondent concerns regarding their patient's access to care (249/524, 47.5%), their desire not to practice or train in a state with abortion restrictions regardless of current residence (249/524, 47.5%), and their personal belief that abortion bans are human rights and/or body autonomy violation (197/524, 37.6%). Some respondents stated that the *Dobbs* decision would not impact their choice of practice location (41/524, 7.8%), and some supported it (35/594, 6.7%).

Conclusions: This study shows that abortion restrictions are having an impact on the practice location preferences of the physician workforce due to both patient care and personal factors. It is important that state policy makers and others who are considering abortion restrictions also consider how to address these concerns of physicians and medical students, to avoid worsening geographic maldistribution of physicians and worsening access to care from physicians for their citizens.

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KEYWORDS

abortion; physician workforce; social media; reproductive health; medical education; abortion access; education; survey study; students; training; patient care; care; medical students; human rights; autonomy

Introduction

The US landmark *Dobbs v Jackson Women's Health Organization* decision allowed for widespread restrictions on abortion care, with 14 US states now enforcing total abortion bans and 27 more with bans based on gestational age [1,2]. These include Targeted Regulation of Abortion Providers (TRAP) laws that hamper and criminalize the practice of abortion [2].

While evidence affirms that abortion restrictions have deleterious effects on patient care and public health [3-6], it is important to understand that such policies also impact the health of physicians. A majority of physicians and medical students plan to build families during or after medical training, with thousands desiring pregnancy each year [7,8]. Many rely on infertility treatments, which abortion restrictions hamper [9]. Abortion restrictions, therefore, may deny a significant proportion of the physician workforce comprehensive family planning services, placing them at risk of forced birth [10]. Furthermore, they may also create moral injury among physicians from conflict between personal and professional morals, uncertainty regarding allowable practices, and fear of prosecution [11]. Those who provide abortion care may face increased stigma or even criminalization, depending on the state in which they train or practice. Those who are in restricted states and are not able to provide abortion care may struggle to navigate what is right for their patients versus what is legal, potentially worsening burnout and compassion fatigue [11,12].

Recent analysis from the American Association of Medical Colleges (AAMC) shows that fewer US MD seniors applied for residency positions in abortion-banned states versus nonban states in 2023 [13]. This includes a small but significant decline in the number of applications to obstetrics and gynecology residency programs in restrictive states in 2022 and 2023 [14]. To date, no study has described why physicians hold such preferences. Using an inductive analysis of free-response survey questions from our previous survey, this study aims to describe how state abortion restrictions may influence physicians' and students' decisions about where to live and practice.

Methods

Overview

We conducted a web-based, cross-sectional study for 2 weeks in August 2022. A nonprobabilistic sample of physicians (practicing physicians, fellows, and residents) and medical students were recruited from dedicated physician communities on social media (Twitter [rebranded as X in July 2023], Facebook, and Instagram [Meta Platforms]) through platforms like the American Medical Women's Association and Inside The Match. All physicians and medical students in the United States were eligible to participate, including both those who practice or intend to practice in reproductive health care and those who do not. There was no minimum age for participation. Physicians completed a questionnaire about the impact of overturning *Roe v Wade* on practice location preferences [15]. Respondents reported demographic information and their location preferences for residency (medical students) or fellowship and jobs (physicians). No identifying information was collected.

This analysis focused on the study respondents' stated practice location preferences. Quantitative data from this study were previously published [15]. Survey respondents were offered a free-response question, "Please share your thoughts about the overturning of *Roe v Wade* and how it will affect your decision about your (residency/job or fellowship) programs." An inductive thematic analysis was used [10]. We consulted the Standards for Reporting Qualitative Research to report the study findings [16]. The free-response item was included to allow respondents to contextualize their practice location preferences [17]. The study team is comprised of a medical student pursuing obstetrics and gynecology (OBGYN; SMM), residents in radiation oncology (MSL) and OBGYN (SF), a fellow in Complex Family Planning (AL), and practicing physicians in psychiatry (SAB and JAG) and internal medicine (SJ and VMA). Some team members practice or are training in locations with abortion restrictions, and some practice in less restrictive locations. A total of 4 independent coders (MSL, SAB, SMM, and SF) coded responses until thematic saturation was reached (n=73 for medical students and n=102 for residents, fellows, and practicing physicians) and established the code book through consensus discussion. After establishing the code book, 2 authors coded all responses (n=524), and differences were resolved by discussion. Statistics were done in IBM SPSS (version 29), and group comparisons were calculated with chi-square testing. The CHERRIES checklist for the reporting of internet surveys guided the reporting of the study (Multimedia Appendix 1) [18].

Ethical Considerations

The study was approved as exempt from review by the Institutional Review Board at the University of Chicago (IRB22-1066). Participants provided consent with the opportunity to opt out of the study and were not compensated

for participation. Data were collected without identifiers and are only accessible to study team members.

Results

Demographics

Of the 2063 survey respondents, 524 (25.4%) completed the free-response item. Respondents consisted of medical students (n=219), residents and fellows (n=129), and practicing physicians (n=176). Most identified as cisgender women (391/524, 74.6%). The majority (453/524, 86.5%) of respondents were of reproductive age (less than age 44) and had no children (361/524, 68.9%). Approximately half (261/524, 50.5%) resided in states where abortion bans were in place or anticipated; half (256/524, 49.5%) resided in states where abortion remains legal [19]. Roughly a fifth (114/524, 21.8%) specialized in OBGYN, 13.2% (69/524) specialized in family medicine, and 65.1% (341/524) specialized in another field. The complete demographics of the sample who answered the free-response portion appear in Table 1.

Respondents who answered the free-response item were similar to those who did not by gender (P=.07), race (P=.13), or whether they intended to provide abortion care (P=.22). Respondents in states with restrictive abortion bans (50.5%) were more likely to respond (P<.001) compared with those in a state without restrictive abortion bans (41.7%).

Free-response rates suggest that these qualitative data appropriately represent the spectrum of views on abortion rights and access. Of the overall sample, 82.3% (1698/2063) indicated they would prefer to apply where abortion access is preserved; among them, 23.1% (393) answered the free-response item versus 76.9% (1305/2063) who did not (P<.001). However, of the 9.7% (200/2063) who did not prefer to apply where abortion access was preserved, 41.5% (83) provided a free response, while 58.5% (117) did not (P<.001). Of the 11.1% (229) who indicated that abortion restrictions do not impact their preferences, 32.8% (75) responded versus 67.2% (154) who did not (P<.001).

Table 1. Demographics of medical students (n=219), residents and fellows (n=129), and practicing physicians (n=176) who answered the free response item.

Characteristic	Total (n=524), n (%)	Medical students (n=219), n (%)[a]	Residents and fellows (n=129), n (%)	Practicing physicians (n=176), n (%)
Gender[b]				
Woman	391 (74.6)	158 (72.1)	94 (72.9)	139 (79)
Man	109 (20.8)	48 (21.9)	30 (23.3)	31 (17.6)
Transgender and/or gender nonconforming	7 (1.4)	4 (1.9)	2 (1.6)	1 (0.6)
Prefer to describe	12 (2.3)	2 (0.9)	0 (0)	3 (1.7)
Prefer not to answer	43 (2.1)	7 (3.2)	3 (2.3)	2 (1.1)
Ethnicity[c]				
Hispanic	45 (8.6)	27 (12.3)	10 (7.8)	8 (4.5)
Not Hispanic	456 (87)	181 (82.6)	114 (88.4)	161 (91.5)
Prefer not to answer	23 (4.4)	11 (5)	5 (3.9)	7 (4)
Race[c]				
American Indian, Alaska Native, Native Hawaiian, or other Pacific Islander	2 (0.4)	2 (1)	0 (0)	0 (0)
Asian	49 (9.4)	18 (8.2)	9 (7)	22 (12.5)
Black, African American, or African	37 (7.1)	19 (8.7)	16 (12.4)	2 (1.1)
Multiracial[d]	27 (5.2)	13 (5.9)	6 (4.7)	8 (4.5)
White	361 (68.9)	140 (63.9)	91 (70.5)	130 (73.9)
Prefer to describe	15 (2.9)	8 (3.7)	1 (0.8)	6 (3.4)
Prefer not to answer	33 (6.3)	19 (8.7)	6 (4.7)	8 (4.5)
Sexual orientation				
Bisexual	51 (9.7)	30 (13.7)	8 (6.2)	13 (7.4)
Gay or lesbian	19 (3.6)	8 (3.7)	4 (3.1)	7 (4)
Heterosexual	404 (77.1)	157 (71.7)	106 (82.2)	141 (80.1)
Queer, pansexual, and/or questioning	21 (4)	7 (3.2)	6 (4.7)	8 (4.5)
Don’t know	3 (0.6)	3 (1.4)	0 (0)	0 (0)
Prefer to describe	6 (1.1)	4 (1.8)	0 (0)	2 (1.1)
Prefer not to answer	20 (3.8)	10 (4.6)	5 (3.9)	5 (2.8)
Age range[e] **(years)**				
≤44	453 (86.5)	218 (99.5)	127 (98.4)	68 (38.6)
≥45	71 (13.5)	1 (0.5)	2 (1.6)	108 (61.4)
Relationship status				
Single	128 (24.4)	72 (32.9)	29 (22.5)	27 (15.3)
Partnered	125 (23.9)	89 (40.6)	29 (22.5)	7 (4)
Married	251 (47.9)	53 (24.2)	68 (52.7)	130 (73.9)
Widowed	2 (0.4)	0 (0)	0 (0)	2 (1.1)
Divorced	5 (1)	1 (0.5)	0 (0)	4 (2.3)
Other	5 (1)	1 (0.5)	1 (0.8)	3 (1.7)
Prefer not to answer	8 (1.5)	3 (1.4)	2 (1.6)	3 (1.7)
Children				
Yes	163 (31.1)	25 (11.4)	22 (17.1)	116 (65.9)

Characteristic	Total (n=524), n (%)	Medical students (n=219), n (%)[a]	Residents and fellows (n=129), n (%)	Practicing physicians (n=176), n (%)
No	361 (68.9)	194 (88.6)	107 (82.9)	60 (34.1)
Respondent's current state of residence, by anticipated abortion restriction[f]				
Ban or likely ban[g]	261 (50.5)	125 (58.4)	66 (51.2)	70 (40.2)
Legal[h]	256 (49.5)	89 (41.6)	63 (48.8)	104 (59.8)
Specialties				
Obstetrics and gynecology	114 (21.8)	51 (23.3)	28 (21.7)	35 (19.9)
Family medicine	69 (13.2)	30 (13.7)	17 (13.2)	22 (12.5)
All others	341 (65.1)	138 (63.0)	84 (65.1)	119 (67.6)

[a]Includes US medical students (n=188) and international medical graduates applying to US residency programs (n=31).

[b]Nationally, medical students are 47.9% female and 52.9% male, residents and fellows are 46.8% female and 53% male, and practicing physicians are 35.9% female and 64.1% male [20].

[c]Nationally, medical students are 0.2% American Indian or Alaska Native, 54.6% White, 21.6% Asian, 6.2% Black or African American, 5.3% Hispanic, 8% multiple races, and 3.5% other. Nationally, residents and fellows are 0.11% American Indian or Alaska Native, 48.9% White, 26.6% Asian, 6% Black or African American, 9.2% Hispanic, 4% multiple races, and 3.1% other. Nationally, practicing physicians are 0.1% American Indian or Alaska Native, 63.9% White, 19.2% Asian, 3.6% Black or African American, 5.5% Hispanic, 2% multiple races, and 5.6% other [20,21].

[d]Respondents who selected more than one option are considered multiracial for the purpose of this study.

[e]Age 15-44 years is defined as reproductive age per the Centers for Disease Control and Prevention [22].

[f]Includes all 50 states, Puerto Rico, and the District of Columbia. Excludes the 7 respondents who indicated "other" on their location [19].

[g]Alabama, Arizona, Arkansas, Florida, Georgia, Idaho, Indiana, Iowa, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Montana, North Carolina, North Dakota, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, Wisconsin, and Wyoming [19].

[h]Alaska, California, Colorado, Connecticut, Delaware, District of Columbia, Hawaii, Illinois, Kansas, Maine, Maryland, Massachusetts, Minnesota, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, Oregon, Pennsylvania, Puerto Rico, Rhode Island, Vermont, Virginia, and Washington [19].

Overview of the Inductive Analysis of Free-Response Survey Answers

There were 2 groups of themes and 2 stand-alone themes. One group described how practice location decisions impact patient care (Table 2), and the other captured workforce-related concerns (Table 3). The remaining themes included no impact and antiabortion sentiment.

Table 2. Patient factors influencing decisions about practice location emerging from the inductive analysis of the following: for students applying to residency, "Please share your thoughts about the overturning of Roe v Wade and how it will affect your residency application and ranking decisions below," and for fellows and practicing physicians, "Please share your thoughts about the overturning of Roe v Wade and how it will affect your decision about your job or fellowship programs" among respondents (n=524).

Theme	Students (n=219), n (%)	Example quote	Physicians (n=305), n (%)	Example quote
Patient access to abortion (or reproductive care)	84 (38)	I'm horrified when I imagine taking care of a teenager who is being forced to carry out a pregnancy. I'm terrified of the burden of caring for a NICU filled with babies who were born despite having anomalies that make their short lives painful. I can only hope I'm not assaulted or become pregnant without the option to terminate.	165 (54)	I want to be able to support my patients to make good decisions about pregnancy. I need to be able to refer people if they need termination of pregnancy. It goes against my ethics to have to deprive someone of that option. I care foremost about my patients. If one of my patients died because she couldn't get an abortion, I wouldn't be able to live with myself.
Did not want politics to interfere with medical care decisions	45 (20)	I never want to be in a situation where I face disciplinary and/or legal consequences for reporting a patient who is miscarrying (spontaneous or induced), and with the current climate, I genuinely fear that we may be moving toward the criminalization of abortion in many places. That risk is not worth it to me when I could train in so many other places.	78 (25)	A politician is unable to grasp the grey areas of obstetric care and the heartbreaking scenarios we encounter. It is bad enough that hospital administrators police our obstetric practice; we do not need another non-medical person telling us how to practice evidence-based medicine.
Challenges of providing any reproductive care to patients with an abortion ban	41 (19)	I was previously set on Ob-Gyn, but I am now looking seriously at other fields because of the politics surrounding women's health care. I don't want to have to worry about legal repercussions for providing the best care to my patients. This has strongly turned me away from Ob-Gyn as a medical specialty.	65 (21)	As an abortion provider, I know that as much as I care about serving a population with unmet needs, the inevitability of burnout working in a place where abortion is severely limited would be too much.
Challenges of providing patient care that is not reproductive in nature	15 (7)	It will significantly impact the ability of every physician to provide care to their patients, regardless of their specialty, as many medical conditions are exacerbated by pregnancy status	47 (15)	I'm a dermatologist, and this affects our practice, too! We prescribe Accutane every day, and if a patient does become pregnant while on this drug due to contraceptive failure, we recommend termination. We prescribe lots of other teratogenic drugs as well for many different cutaneous diseases, especially methotrexate. I don't know how I can practice in a state where pharmacists might refuse to fill MTX.

Table 3. Practice location decisions that are workforce-related emerging from the inductive analysis of the following: for students applying to residency, "Please share your thoughts about the overturning of Roe v Wade and how it will affect your residency application and ranking decisions below," and for fellows and practicing physicians, "Please share your thoughts about the overturning of Roe v Wade and how it will affect your decision about your job or fellowship programs" among respondents (n=524).

Theme	Students (n=219), n (%)	Example quote	Physicians (n=305), n (%)	Example quote
Not choosing to practice or train in a state with abortion restrictions	77 (35)	This decision has heavily affected my residency application process. Amazing programs that I've highly considered are now at the bottom of my list.	172 (56)	Just finished residency and specifically did not even consider jobs in states that ban the full spectrum of reproductive healthcare or states that looked like they would consider a ban. Overturning of Roe made me basically have to ignore half the country during my search. But given the job market today, finding a position in a state that allows me to actually care for my patients wasn't hard.
Personal belief that an abortion ban is a human rights/body autonomy violation	63 (29)	States that do not respect basic human rights are not places I wish to live or raise a family.	134 (44)	The overturning of Roe is the overturning of basic freedoms, the right to privacy, and bodily autonomy. It is the first step in overturning other rights. It is removing science from medicine. It threatens all doctors whether they provide abortion care or not. I'm likely to leave medicine, then practice in that environment and take those risks.
Access to training and education in abortion	43 (20)	I want to be part of a program where abortion training is easily accessible, and I will not have to go out of state to get this training. I also want to protect these rights for myself and my future patients.	15 (5)	One of my biggest decisions in choosing my state of residency was to allow me every opportunity to learn about women's care at all levels. The overturning will prevent students and residents from reaching their full potential of learning care for women. It is truly unfortunate that men outside of the walls of understanding of medical knowledge think they have the authority to control not only women's bodies but also the education of those to be able to treat women in emergency settings safely and holistically.
Personal or family access to abortion care or family building	36 (16)	I'm a guy, but what about my daughters in the future? What about a pregnancy complication with my wife? What about my patients? This is the problem when people claim moral high ground on the basis of their religion and are placed into positions of power; you end up with a sort of theocracy.	58 (19)	I was planning on looking for underserved community jobs in Idaho, but now that they have an early abortion ban, I will not be. I am actively trying to get pregnant and won't risk my life to pursue a job.
Geographic ties to states with abortion restrictions limiting relocation	18 (8)	I attend medical school in my home state, which hasn't banned abortion as of yet but might do so in the future. If abortion is banned here, I'll likely still rank in-state programs due to the proximity of my family, but I will not rank out-of-state programs where abortion is banned.	38 (12)	Unfortunately, my answers are influenced by the fact that I live in a state with some of the most restrictive policies and have no ability to move. I cannot simply uproot my life to another state due to my feelings on abortion access. I work here, and my husband works here. My family is here. His family is here. The best I can do is to advocate for change, but I must remain in place as the primary breadwinner in my family.
Challenges recruiting to states with abortion restrictions	0 (0)		18 (6)	I'm a program director and am concerned about how this will affect recruiting talented and eager physicians to our state. Our patients already have difficulty accessing the medical system, so if this decision leads to physicians leaving the state, it will only amplify disparities.

Patient Factors Influencing Decisions About Practice Location

Patient Access to Abortion or Full-Spectrum Reproductive Care

Many physicians and medical student respondents want patients to have access to safe and legal abortion. Respondents specifically highlighted concerns that adolescents, underrepresented minority groups, people in rural communities, and lower-income patients would increasingly face challenges in finding abortion providers, exacerbating health disparities (Table 2).

Physicians also noted that restrictions interfere with their ability to provide or refer patients for abortion care. For example, one stated, "I won't practice in a state that limits my ability to provide or refer my patients for care that is safe and necessary for their health and well-being."

Challenges of Providing Reproductive Care to Patients During an Abortion Ban

Reproductive health care providers anticipate moral distress if they are unable to provide abortion care in circumstances like lethal fetal anomalies or pregnancies resulting from rape or incest. An OBGYN physician explained, “Abortion care and prenatal care go hand in hand. This is a field with a lot of gray areas, and elimination of options will harm those who can get pregnant.” Many physicians feared legal repercussions and were disappointed by a perceived lack of institutional support for evidence-based health care.

Do Not Want Politics to Interfere With Medical Care Decisions

Some respondents expressed concern that lawmakers are interfering with medical care. Others emphasized the role physicians play in advocacy and supporting elected officials in favor of essential reproductive health care. A participant stated, “The government should have no standing in a medical decision between physician and patient.”

Challenges of Providing Patient Care That Is Not Reproductive in Nature

Physicians across various fields were concerned that abortion restrictions would adversely impact their clinical practice. For example, a pediatrician noted, “Working with fetal cardiac patients, it is imperative that my patients have access to abortion services if that’s the choice they make that’s best for their families.” In addition, an oncologist worried about restrictions on chemotherapy regimens, a dermatologist had questions about prescribing common medications (like Accutane) that are teratogenic, and a rheumatologist had concerns about prescribing methotrexate.

Workforce-Related Practice Location Decisions

Choosing Not to Practice or Train in a State With Abortion Restrictions

Many respondents living in states with abortion protections stated that they would be unwilling to move to a state with abortion restrictions (Table 3). Others living in restrictive states intend to move or preferentially apply to and rank training programs in states without abortion bans. Trainees described how these decisions compound their stress regarding the highly competitive match process. Some still felt pressured to apply everywhere, regardless of their personal preferences, stating, “Residency is already so competitive, so unfortunately, I feel like I have to apply everywhere, but I would definitely preferentially rank somewhere that I would have access to abortion care and that my patients would as well.”

Challenges Recruiting to States With Abortion Restrictions

Some residency and fellowship program directors and administrative leadership in states with restrictive abortion laws are concerned about recruiting and retaining residents, fellows, and faculty. Many foresee the reluctance of trainees and faculty to work in restrictive states. A program leader said, “I am an APD at an academic medical center in the Midwest. I have already been told by two residents that they had planned to stay in the state to practice but are now leaving solely because of the lack of reproductive rights in our state. I fear we will rapidly lose amazing physicians.”

Personal Belief That Abortion Restrictions Violate Human Rights and/or Bodily Autonomy

A substantial portion of respondents described the overturning of *Roe v Wade* as a human rights violation and criticized its negative impact on patients’ bodily autonomy. Others discussed the potential moral injury from practicing in a state whose laws and policies prevent clinicians from providing evidence-based medical care.

Respondents connected states’ abortion policies to their overarching sociopolitical climates, noting that bans and restrictions may portend other harmful (eg, racist, homophobic, transphobic) policies. A medical student said, “Extremely cautious about applying to these states who have denied abortion care. Not only because of abortion care but also because these states are notoriously anti-LGBTQ+ and hold racist values. I do not want to live and work and raise a family in that environment, where I am not respected and have less human rights than others.”

Access to Abortion Training and Education

Students applying to OBGYN and family medicine expressed that their application decisions would be shaped by access to proper training in abortion care. Applicants to residency and fellowship recognize that selecting programs in abortion-restricted states may limit access to adequate training. Multiple students noted that they intend to inquire about abortion training during the residency application process.

Some recognized that trainees in abortion-restricted states could seek abortion training out-of-state. For example, a respondent said, “I plan to first rank programs in states with full spectrum reproductive health access, followed by programs that are intentional about providing training for their residents with full support (financial, housing, etc) to leave the state for abortion training.” However, current trainees also discussed challenges in obtaining abortion training, including professional, administrative, and financial barriers.

Geographic Ties to States With Abortion Restrictions Limiting Relocation

Some noted that geographic relocation is a privilege not afforded to everyone equally. The decision to move is often influenced by distance to a support network, job benefits for the respondent or their spouse, housing, and childcare. Such geographic ties discourage or prevent many medical students and physicians from leaving their state of residence despite their personal or professional opposition to abortion restrictions.

Some said they understand the risks of staying in a state with abortion restrictions. If necessary, they would travel out of state to receive an abortion, again recognizing their mobility is a privilege. A respondent said, “I definitely would prefer to be in a state that maintains access to abortion. Unfortunately, those are not states where my family lives, and I am grateful that I

have enough privilege if I needed an abortion, I could leave the state."

Personal or Family Access to Abortion Care or Family Building

Respondents were concerned about practicing in a location that limits their options for receiving comprehensive reproductive health care. Multiple respondents highlighted that they did not want to be forced to carry a pregnancy if they could not get an abortion, especially during training. Others specifically cited medical conditions that would make pregnancy physically challenging and even contraindicated as a reason to ensure they had access to abortion care. A respondent said, "I am a medical student with chronic conditions that make pregnancy life-threatening for me. Although I am on contraceptives, nothing is 100%, and I want to be able to protect my life and well-being in case I do accidentally get pregnant."

In addition, physicians with infertility undergoing in vitro fertilization noted that practicing in a state where life is defined as beginning at fertilization would make family building significantly more challenging. Commonly, respondents stated they were concerned about care for themselves, their children, or their partners, underscoring the importance of recognizing that physicians, too, need access to care.

Additional Themes

No Impact

Few medical students and physicians stated that the *Dobbs* decision would not impact their choice of practice location (Table 4). Some indicated that the residency and fellowship match were too competitive to make decisions based on abortion legislation. For example, those who apply to every program in their field may end up applying to programs in states with abortion restrictions to increase their likelihood of matching.

Table 4. Practice location decisions that are workforce-related emerging from the inductive analysis of the following: for students applying to residency, "Please share your thoughts about the overturning of Roe v Wade and how it will affect your residency application and ranking decisions below," and for fellows and practicing physicians, "Please share your thoughts about the overturning of Roe v Wade and how it will affect your decision about your job or fellowship programs" among respondents (n=524).

Theme	Students (n=219), n (%)	Example quote	Physicians (n=305), n (%)	Example quote
No impact	30 (14)	Matching and getting into a program is challenging enough considering the various factors at play; this decision will not be part of deciding which states or programs I end up applying to.	11 (4)	It will have zero impact on my decisions regarding jobs/fellowships.
Expressed support for overturning *Roe v Wade*	17 (8)	The overturning of Roe v. Wade is long overdue. It was not right in the first place, as the Supreme Court made clear in its ruling. Babies deserve to live inside and outside the womb.	18 (6)	I am supportive of the overturn and believe it will be better for our patients and medical care to ban an inhumane practice like abortion. Human lives in the womb deserve protection just like all of our other patients at any age and ability.

Expressed Antiabortion Sentiment and/or Support for Overturning Roe v Wade

Physicians and medical students who expressed antiabortion ("pro-life") views supported the Supreme Court decision (Table 4). Multiple respondents noted that they would purposefully seek out practice environments where abortion restrictions existed. Reasons for this include not supporting abortion care for any indication, stating that they do not view abortion as health care, a desire to "preserve life," and a desire to "protect the unborn." Multiple respondents discussed that abortion is an issue that should be legislated at the state level.

Discussion

Principal Findings

Our study shows that abortion restrictions will have a substantial impact on the physician workforce in patient care and practice location decisions. The 3 most common themes were patient access to care, not choosing to practice or train in a state with abortion restrictions, and personal belief that an abortion ban is a human rights/body autonomy violation. This study enhances emerging literature about the impacts of abortion restrictions on the physician workforce, including physicians and medical students at all levels of training across all 50 states within both reproductive and nonreproductive health fields.

Respondents shared concerns that abortion restrictions will negatively impact their ability to provide high-quality, comprehensive reproductive care. This was evident among trainees who provide abortion care, like OBGYN residents, who expressed concerns about new or worsening barriers to obtaining foundational skills like first-trimester uterine aspiration at their primary institution [23,24]. OBGYN trainees also cited multiple barriers to obtaining foundational abortion care skills at their primary institutions. Some programs have created away rotation opportunities for residents unable to obtain comprehensive abortion training at their own institutions [25]. However, there are many barriers to these programs, including obtaining state-based medical licenses, getting funding and organizational affiliations in place, and disruptions to families when living in another state [25].

Even within nonreproductive health care fields, respondents shared concerns about the downstream effects of abortion restrictions on clinical training and practice. In the 2 weeks following the *Dobbs* decision, only 38.5% of a list of 187 societies across a wide variety of specialties had made a statement about the decision [26]. Respondents from specialties

that do not provide abortion care noted concern for restricted use of potentially abortifacient or teratogenic medications and worsening health among patients whose physical or mental health will be adversely impacted by restrictions.

Physicians and medical students also worried that abortion restrictions would deleteriously affect their personal health and well-being. Restrictions hold significant health implications for reproductive-age women, a large and growing demographic of the physician workforce [27]. Recent studies have reported that abortion is common among physicians, affirming that physicians, too, need safe, legal access to abortion [28]. This study informs future medical education and occupational health research by elevating trainees' and employees' concerns. As highlighted by the medical student responses on geographic ties and competitiveness of the match process, it is critical to recognize the multifactorial decision-making involved in where to complete residency training. While before the *Dobbs* decision, telehealth may have been able to bridge the gaps in access to abortion care, this is less likely to be possible in the current landscape [29]. Medical schools and hospitals, especially those in restrictive states, must recognize this and prepare to navigate the adverse health, financial, and legal repercussions their employees may face. Otherwise, disparate abortion access may increase health disparities within the physician workforce and threaten its diversity and resiliency [30].

If medical students do not want to practice in states with abortion restrictions in place, it is less likely that they will establish their practice in those locations. In 2022, 55.2% of those completing training established their practice in the same state where they completed residency [31]. The lack of physicians who are willing to practice in states with abortion restrictions can further poor health outcomes in maternity care deserts [32,33]. Idaho is a notable example, where 41% of OBGYN physicians consider leaving and cite restrictive abortion laws as a motivation [34,35]. Idaho has the lowest rate of physicians per 100,000 people in the entire country [34,35].

Some physicians stated that abortion restrictions would not impact them or that they support them. Notably, a subset of "no impact" responders shared that the scarcity of available positions, particularly within highly competitive specialties and for historically marginalized applicants, outweighs their personal opposition to abortion restrictions. Others acknowledged the futility of setting preferences since the match is ultimately complex and multifactorial.

Limitations

This study may be limited by self-selection bias, given its recruitment of medical students and practicing physicians on social media. Of the respondents who did not prefer to apply where abortion access was preserved, a substantial number (41.5%) provided a free response, indicating that we had a spectrum of views on abortion rights. Furthermore, this sample is focused on physicians and does not represent other health care workforce members who are likely also impacted by abortion restrictions.

Conclusion

The findings of this study captured responses to abortion restrictions before the 2023 Match cycle and provided context to the recent AAMC data showing that residency applications disproportionately decreased in restrictive states [13]. Narrative responses bolster our original quantitative data, affirming that access to full-spectrum reproductive health care was highly valued personally and professionally by most physicians [15].

This study shows that abortion restrictions are having an impact on the practice location preferences of the physician workforce due to both patient care and personal factors. It is important that state policy makers and others who are considering abortion restrictions also consider how to address these concerns of physicians and medical students, to avoid worsening geographic maldistribution of physicians and worsening access to care from physicians for their citizens.

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Generative artificial intelligence was not used to aid in writing this manuscript.

Data Availability

The datasets generated during and/or analyzed during this study are not publicly to protect the anonymity of participants due to the sensitive subject matter of this manuscript but are available from the corresponding author on reasonable request.

Authors' Contributions

MSL and SAB contributed equally as cofirst authors. SAB and MSL had full access to all of the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. SAB, MSL, JAG, and VMA contributed to the concept and design. All authors contributed to the acquisition, analysis, or interpretation of data. SAB, MSL, SMM, JAG, and VMA contributed to the drafting of the manuscript. All authors contributed to the critical revision of the manuscript for important intellectual content. MSL performed statistical analysis. JAG and VMA contributed to administrative, technical, or material support. JAG and VMA performed supervision.

Conflicts of Interest

None declared.

Multimedia Appendix 1
The Checklist for Reporting Results of Internet E-Surveys (CHERRIES).
[PDF File (Adobe PDF File), 316 KB - ijmr_v14i1e55035_app1.pdf]

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Abbreviations

AAMC: American Association of Medical Colleges
OBGYN: obstetrics and gynecology
TRAP: Targeted Regulation of Abortion Providers

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Original Paper

Citizen Worry and Adherence in Response to Government Restrictions in Switzerland During the COVID-19 Pandemic: Repeated Cross-Sectional Online Surveys

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Abstract

Background: Good communication between health authorities and citizens is crucial for adherence to preventive measures during a pandemic. Crisis communication often appeals to worries about negative consequences for oneself or others. While worry can motivate protective behavior, it can also be overwhelming and lead to irrational choices or become a mental health problem. Also, the levels and consequences of worry can differ between different groups of citizens. Little is known about the evolution of worries during the pandemic and adherence to measures in distinct groups.

Objective: This study aimed to evaluate worries in the Swiss population as well as associations between worry levels and citizens' adherence to government restrictions during different phases of the COVID-19 pandemic.

Methods: We carried out an observational study with 4 cross-sectional online surveys of adults in the Canton of Vaud, Switzerland. Questionnaires were distributed through social media and websites during 4 periods: survey 1: April 17 to May 14, 2020; survey 2: May 15 to June 22, 2020; survey 3: October 30 to December 12, 2020; and survey 4: June 18 to December 30, 2021. On visual analog scales from 0 to 100, participants reported worry, self-adherence to pandemic restrictions, and their perceived adherence to others. We used multivariable linear regression, adjusting for age, gender, health literacy, and education to assess associations between self-reported worry, adherence, and study periods.

Results: We collected 7106 responses. After excluding 2377 questionnaires (incomplete, age <18 years, residence outside Vaud), 4729 (66.55%) were analyzed (mean age 47, SD 15.6 years, 63.96% women). Mean worry across the 4 periods was 42/100, significantly higher in women (44.25/100, vs 37.98/100; P<.001) and young people (43.77/100 in those aged 18-39 years, vs 41.69/100; P=.005; in those aged 40-64 years and 39.16/100; P=.002; in those aged >64 years). Worries were higher during survey 1 and survey 3 (52.41/100 and 56.32/100 vs 38.93/100, P<.001; and 35.71/100, P<.001) than during survey 2 and survey 4, respectively. This corresponds to pandemic peaks during which federal restrictions were better followed with self-reported adherence of 84.80/100 and 89.59/100 in survey 1 and survey 3 versus 78.69/100 (P<.001) and 78.64/100 (P<.001) in survey 2

and survey 4. A 2.9-point increase in worry score, adjusted for the pandemic period, gender, age, education, and health literacy, was associated with a 10-point increase in personal adherence score (95% CI 2.5-3.2; *P*<.001).

Conclusions: Worries were higher in women, young people, and during the peak of the COVID-19 pandemic. Higher worry levels were associated with increased self-reported adherence to federal restrictions. Authorities should consider population worry levels and population subgroups in the planning and design of pandemic communication.

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KEYWORDS

COVID-19 pandemic; citizens; worry; anxiety; communication; prevention; adherence; restrictions; Switzerland; cross sectional; online survey; survey; Swiss; adults; questionnaire; social media; linear regression; age; gender; health literacy; education; women; young people

Introduction

Effective communication between health authorities and the population is crucial to achieving public health goals during a pandemic. Providing clear, consistent, and reliable information that motivated behavior changes without triggering resistance was a major challenge during the COVID-19 pandemic. Sanitary restrictions were often rapidly issued and modified to contain the spread of the disease [1-3]. Citizens were expected to make drastic behavioral changes.

Public health authorities stressed the seriousness and risks of the pandemic to justify restrictions and encourage citizens' adherence to them. In support of such an approach, the Health Belief Model argues that preventive health behaviors are influenced by perceived susceptibility to illness, the severity of the disease, benefits of and barriers to health-promoting actions, cues to action, as well as self-efficacy [4]. Also, during the COVID-19 pandemic, protective behaviors were associated with these factors, especially when the "perceived benefit" of a measure was clear [5].

Appealing to emotions such as fear can hence be a persuasive way of motivating respect for protective measures [6,7]. Indeed, fear leads to behavioral change if people feel capable of dealing with the threat, while they become defensive when feeling helpless and incapable of acting [8-10]. Overdriven or ill-conceived fear-based communication may even provoke counterproductive behavior.

Levels of anxiety, worry, and stress were high during the pandemic. According to a systematic review and meta-analysis, anxiety prevalence was around 30% worldwide after the first COVID-19 wave [11]. Others have confirmed these findings [12,13]. Among professionally active persons, 42% of participants reported being worried about the COVID-19 pandemic in August and September 2020 [14]. Young adults in the city of Zurich, Switzerland, reported elevated stress levels in April 2020, in the aftermath of the first wave [15], as was found more generally in Swiss adults too [16]. In terms of risk factors, anxiety was higher in women, younger people, and vulnerable persons [17-19].

In our previously published cross-sectional population survey, performed during the first wave of the pandemic, we found high self-reported adherence to official restrictions, which increased with age and level of worry [20]. As in the aforementioned studies, worry was high, particularly among people in isolation and with lower health literacy. Nearly half of the respondents felt that government responses were adequate or, associated with higher levels of worry, even insufficient. Neither the aforementioned nor our cross-sectional study could determine the evolution of these associations throughout the pandemic.

Thus, we conducted surveys during different phases of the pandemic to describe the evolution of worries in the Swiss population as well as associations between worries and adherence to governmental restrictions. Our overall aim was to contribute new insights to this understudied area to help improve crisis communication during future pandemics.

Methods

Study Design and Setting

We conducted repeated cross-sectional online surveys in Vaud, a French-speaking canton of 823,000 inhabitants (2021) in Switzerland. We launched 4 surveys between April 2020 and December 2021: survey 1 between April 17 and May 14, 2020 (4 weeks); survey 2 between May 15 and June 22, 2020 (5.5 weeks); survey 3 between October 30 and December 1, 2020 (4.5 weeks); and survey 4 between June 18 and December 30, 2021 (28 weeks, Table 1). Some of the survey items were adapted or replaced to capture changes in federal measures. We followed the CHERRIES (Checklist for Reporting Results of Internet e-Surveys) guidelines [21]. Self-reported worry was an outcome of the study of worry levels and an exposure variable for the study of associations between worry and self-reported adherence during these 4 COVID-19 pandemic periods.

Table 1. Surveyed periods and sentinel pandemic-related events.

Survey	Period	Number of weeks	Sentinel events
Survey 1: End of the first pandemic wave	April 17, 2020, to May 14, 2020	4	• March 16, 2020: Semiconfinement, only essential shops open, gatherings of a maximum of 5 people • April 27, 2020: Partial reopening of shops • May 11, 2020: Reopening of schools
Survey 2: After the first pandemic wave	May 15, 2020, to June 22, 2020	5.5	• June 19, 2020: End of an extraordinary situation
Survey 3: During the second pandemic wave	October 30, 2020, to December 1, 2020	4.5	• Mandatory wearing of masks in indoor public spaces; gatherings limited to 15 people
Survey 4: Following pandemic waves	June 18, 2021, to December 30, 2021	28	• Vaccination available to all, use of COVID-19 vaccination certificate

Table 1 presents the COVID-19 waves and their duration in the French-speaking part of Switzerland. The first and second forms were distributed at the end of the first wave, corresponding to the gradual emergence from confinement. The third form was distributed over a longer period, which included the second wave and the resumption of restrictive measures. The fourth form was distributed once vaccination was available for the entire population.

Participant Recruitment

Using a weblink, we distributed the surveys on the social media platforms of multiple community organizations to collect a convenience sample of the population. These organizations were a regional consumer organization, regional disease leagues for cancer and diabetes, the association of senior citizens as well as the cantonal websites for the COVID-19 testing and vaccination decisions. These cantonal sites were used by large portions of the population. The organizations advertised the study through links on their websites and some social media accounts. The links were accompanied by a short explanation of the study and its purpose. No incentives to participate were given. The online interface for the survey was created in REDCap (Research Electronic Data Capture, Vanderbilt University).

Surveys

The development and testing of the survey are described in our previous publication with results from survey 1 [20]. Each survey was submitted to 5 nonmedical persons to test the understandability of questions. There was no review step for this short questionnaire. The first, second, and fourth surveys had 20 items, and the third survey had 25 items. A total of 12 items remained unchanged throughout all surveys. We included demographic data, such as age, sex, number of persons per household, canton of residence, level of education, literacy, and whether the respondent had been tested for the COVID-19 pandemic. For the literacy question, we used a validated item from Chew et al [22]. Employment status was included in surveys 2-4. Respondents rated (1) worry about the pandemic situation, (2) self-reported adherence to government restrictions, and (3) perceived adherence of others to government restrictions, on visual analog scales from 0 to 100 (0=not at all; 100=in all situations). Items were not randomized. Participants could go back to earlier questions at any time. Adaptive questioning was used for several items. The first 2 surveys took up 6 screens, and the 2 latter, 7. REDCap automatically generated a completeness variable if participants went all the way to the end of the survey. Anyone who opened the survey generated a response. We did not determine unique site visitors, establish view or participation rates, or IP address checks, as surveys were entirely anonymous and the risk of repeating them was low. The time used to fill them in was not registered. No cookies were used, and there were no other techniques to analyze the log file of our database. Statistical corrections were not used. The 4 surveys can be found in Multimedia Appendices 1-4.

Statistical Analyses

The item “Level of education” was dichotomized into “university or college education” or other. Health literacy was dichotomized according to ease of answering a medical form on one’s own: low literacy (“never,” “rarely,” or “sometimes” at ease) and “high literacy” (“often” or “always”). This was based on a validated item [22] and our previous article [20].

We limited our analysis to complete questionnaires for 2 reasons. First, the survey was distributed using an online link on government websites and a large number of persons clicked the link but only completed 1 or 2 questions. Second, no single question had many missing responses and we preferred to maintain consistency across surveys. We calculated means with SD and frequencies with IQR as appropriate. Independence between surveys was tested with the *t* test for continuous variables (eg, age), and with the chi-square test for gender, education, and health literacy. We performed linear regressions to analyze associations between the 4 periods and level of worry (model A), self-reported adherence (model B), and perceived adherence of others to restrictions (model C). First, we performed univariate linear regression, followed by multivariable linear regression controlling for age (grouped as 18-39 years, 40-64 years, and 65 years or older), sex (dichotomized male-female), level of education (dichotomized university education or other), and health literacy (dichotomized high or low health literacy). We subsequently used the margins command in Stata (StataCorp) to report absolute differences in the predicted levels of worry or adherence with each model. The level of significance was set to $P<.05$. Statistical analyses were performed in Microsoft Excel and Stata (version 16.1).

Ethical Considerations

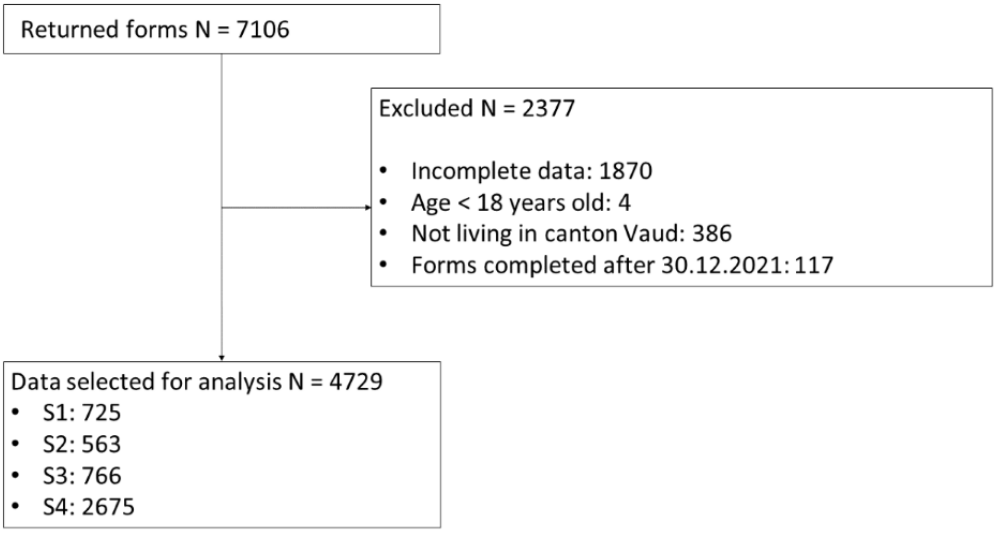
According to the Cantonal Commission on Ethics in Research Involving Human Beings of the Canton of Vaud, Switzerland the study was exempted from ethical review because it did not qualify as human subjects research and all data collection was anonymous (2024-010901).

Results

Participant Characteristics

Citizens completed 7106 surveys between April 17, 2020, and December 20, 2021. After the exclusion of minors, persons living outside the Canton, and incomplete questionnaires, 4729 (66%) surveys remained. The number of questionnaires per period ranged between 563 and 2675 (Figure 1).

Figure 1. Study participants.



The participants were more often women (3025/4729, 63.96%) and between 40 and 64 years old (2442/4729, 51.64%). Furthermore, 2526/4729 (53.42%) of participants had attended university or college, and 4510/4729 (95.37%) reported high health literacy. The participants were younger in survey 3 (mean age 43.2, SD 14.6 years; P<.001) than in the other surveys (survey 1: mean age 47.9, SD 14.6 years; survey 2: mean age 47.3, SD 15.6 years; and survey 4: mean age 48.7, SD 15.3 years; Table 2).

Table 2. Demographics, education, health literacy, and employment of participants (n=4729).

Variables	All surveys	Survey 1[a]	Survey 2[b]	Survey 3[c]	Survey 4[d]
Age (years), n (%)					
18-39	1574 (33.3)	244 (33.7)	202 (35.9)	325 (42.4)	803 (30)
40-64	2442 (51.6)	365 (50.3)	268 (47.6)	369 (48.2)	1440 (53.8)
≥65	713 (15.1)	116 (16)	93 (16.5)	72 (9.4)	432 (16.1)
Years, mean (SD)	47.5 (15.3)	47.9 (14.6)	47.3 (15.6)	43.2 (14.6)	48.7 (15.3)
Gender, n (%)					
Male	1698 (35.9)	168 (23.2)	178 (31.6)	264 (34.5)	1088 (40.7)
Female	3025 (64)	557 (76.8)	384 (68.2)	502 (65.5)	1582 (59.1)
Other[e]	6 (0.1)	0 (0)	1 (0.2)	0 (0)	5 (0.2)
Education, n (%)					
Obligatory school or less	256 (5.4)	12 (1.7)	21 (3.7)	28 (3.7)	195 (7.3)
Apprenticeship	1379 (29.2)	171 (23.6)	131 (23.3)	209 (27.3)	868 (32.4)
High-school graduation	502 (10.6)	69 (9.5)	47 (8.3)	85 (11.1)	301 (11.3)
University or college	2526 (53.4)	466 (64.3)	358 (63.6)	434 (56.7)	1268 (47.4)
I do not know	66 (1.4)	7 (1)	6 (1.1)	10 (1.3)	42 (1.6)
Health literacy, n (%)					
Low health literacy	219 (4.6)	52 (7.2)	33 (5.9)	74 (9.7)	344 (12.9)
High health literacy	4510 (95.4)	673 (92.8)	529 (94.1)	692 (90.3)	2326 (87.1)
Employment[f], n (%)					
Full-time work	1707 (42.6)	—[g]	225 (40.0)	347 (45.3)	1135 (42.4)
Part-time work	674 (16.8)	—	102 (18.1)	136 (17.8)	436 (16.3)
Housewife and husband	125 (3.1)	—	18 (3.2)	24 (3.1)	83 (3.1)
Self-employed	303 (7.6)	—	37 (6.6)	46 (6.0)	220 (8.2)
Student	241 (6)	—	31 (5.5)	72 (9.4)	138 (5.2)
Employment status, n (%)					
Unemployed and currently looking for a job	133 (3.3)	—	23 (4.1)	19 (2.5)	91 (3.4)
Unemployed and not currently seeking employment	57 (1.4)	—	8 (1.4)	14 (1.8)	35 (1.3)
Incapacity	129 (3.2)	—	11 (2)	26 (3.4)	92 (3.4)
Retired	619 (15.5)	—	105 (18.7)	81 (10.6)	433 (16.2)
Unknown	15 (0.4)	—	3 (0.5)	1 (0.1)	11 (0.4)

[a]Survey 1: April 17 to May 14, 2020.

[b]Survey 2: May 15 to June 22, 2020.

[c]Survey 3: October 30 to December 1, 2020.

[d]Survey 4: June 18, 2021, to December 30, 2021.

[e]These were excluded from the regression analyses.

[f]Employment data were not collected during the first survey.

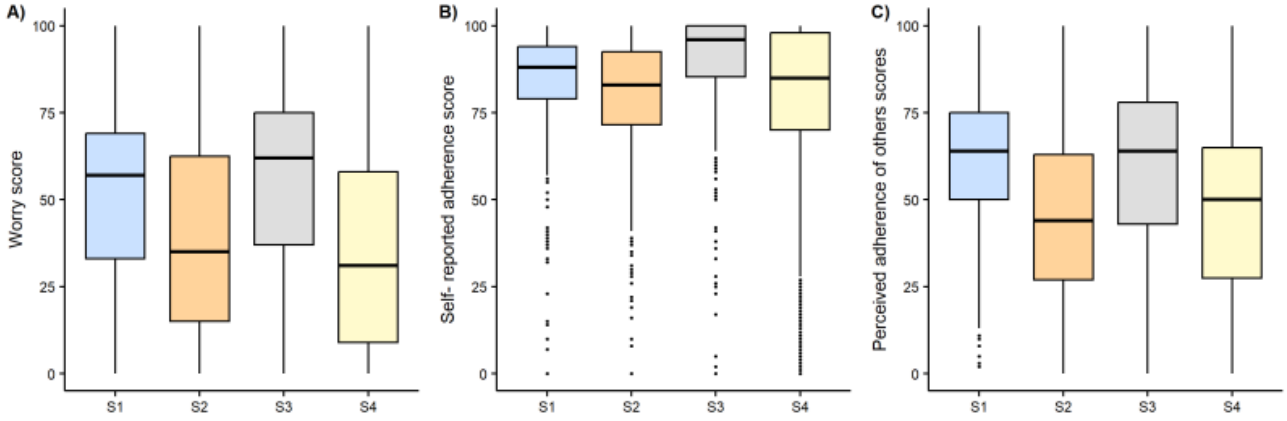
[g]Not available.

Main Results

Self-Reported Worry

Overall, the mean level of self-reported worry was 42.0% (SD 28.9). Upon univariate regression, self-reported worry levels differed significantly across surveys, with significantly higher levels in survey 1 (52%, 95% CI 50-54) and survey 3 (56%, 95% CI 54-58; Figure 2). Upon multivariable regression, the female gender was associated with a 4-point increase in level of worry (95% CI 2-5 points). Worry levels were 2 (95% CI 1-4) and 4 (95% CI 1-6) points lower among respondents aged 40 to 64 and over 64, respectively, when compared with the 18- to 39-year group. Higher health literacy was associated with a 3-point lower worry level (95% CI –6 to –1). Education was not associated with significant changes in self-reported level of worry (Table S5 in Multimedia Appendix 5).

Figure 2. Boxplots on a 0-100 scale of (A) worry, (B) self-reported adherence, and (C) perceived adherence of others to restrictions during four COVID-19 pandemic periods (April 17, 2020, to December 30, 2021), Switzerland. S: survey; survey 1: April 17 to May 14, 2020; survey 2: May 15 to June 22, 2020; survey 3: October 30 to December 1, 2020; survey 4: June 18, 2021, to December 30, 2021.



Self-Reported Adherence to Restrictions

Overall, respondents evaluated their own adherence to government restrictions at 81.4% (SD 21.1). Self-reported adherence was significantly (P<.001) higher in survey 1 (mean 84.8%, SD 14.2) and survey 3 (mean 89.6%, SD 15.5; Figure 2). A 2.9-point increase in the worry score was associated with a 10-point increase in self-reported adherence (95% CI 2.5-3.2; P<.001) after adjusting for the pandemic period, gender, age, education, and health literacy. These effects were more pronounced in women and older participants (Table S5 in Multimedia Appendix 5). Moreover, both older age categories (40-64 years and more than 64 years) were associated with a 7-point higher self-reported adherence than in the 18-39 years group (95% CI 6-8 for 40- to 64-year-olds and 6-9 for >64-year-olds). Higher health literacy was associated with a 4-point increase in self-reported adherence (95% CI 2-6) while the educational level was not (Table S5 in Multimedia Appendix 5).

Perceived Adherence of Others to Restrictions

Overall, respondents evaluated the adherence of others to government restrictions at 50.4% (SD 24.5%). Evaluated adherence did not differ between survey 1 and survey 3 nor between survey 2 and survey 4 but was significantly higher (P<.001) in survey 1 (mean 60.1%, SD 20.0%) and survey 3 (59.6%, SD 24.6%) than in survey 2 (45.1%, SD 22.5%) and survey 4 (46.2%, SD 24.5%; Figure 2). Adjusting for participant characteristics, age groups 40-64 years and >64 years were associated with, respectively, a 5- or 7-point higher perceived adherence of others (95% CI 3-6 and 5-9, respectively). A 10-point increase in worry level was associated with a 1-point decrease in perceived adherence of others to restrictions (95% CI –0.9 to –0.4). Higher education level was associated with a 1.5-point higher perceived adherence of others (95% CI, 0-3), whereas gender and health literacy were not (Table S5 in Multimedia Appendix 5).

Changes to the Daily Lives of Respondents

During the first period (survey 1), most respondents had experienced changes in their daily life (Table S6 in Multimedia Appendix 6). Later (surveys 2-4), 35% to 49% had either lost their job or had to close their business and 21% to 34% had lost part of their income. Respondents also reported feeling isolated, lonelier, and less productive during surveys 2 to 4. In decreasing order of importance, concerns during survey 3 were for “vulnerable people,” “living conditions,” the “economy,” “self and family,” “working conditions,” and the “possibility of another wave.” During survey 4, these concerns were similar but generally rated lower. Interestingly, “deterioration of working conditions” moved up from fifth to third rank, which had been “self and family” in survey 3 (Multimedia Appendix Table S7 in Multimedia Appendix 7 and Table S8 in Multimedia Appendix 8).

Discussion

Principal Findings

We conducted online surveys during different phases of the COVID-19 pandemic to describe the evolution of worry levels and to assess how these were associated with adherence to government restrictions. In Switzerland, the self-reported worry was highest during the first and second pandemic waves, corresponding to survey 1 and survey 3, at times of many COVID-19–related hospitalizations and deaths, and when a vaccine was not yet available. Women and younger people

reported higher levels of worry than men and older people. Education did not influence worry levels, while lower health literacy was associated with higher worry. Higher worry levels were associated with higher self-reported and perceived adherence of others to federal restrictions.

We found elevated worry levels during the more dramatic phases of the pandemic. In a systematic review covering 204 countries in 2020, higher anxiety was associated with higher COVID-19 incidence [23], a finding that was confirmed by Salanti et al [13]. In March 2020, Fitzpatrick et al [24] found that in a national sample in the United States, worry was higher in the regions with high COVID-19 incidence. In Ontario, Canada, COVID-19–related worry in young persons also increased during the early phases of the pandemic and then again in the autumn of 2020, when the incidence was higher [25]. So, anxiety and worry varied during the pandemic and increased repeatedly with the rising incidence of COVID-19. This is in line with findings on decreased mental health on a larger scale during the pandemic [11,26].

In periods of increased worry, we found higher self-reported adherence to government restrictions. Similarly, a study in Saudi Arabia described an association between higher anxiety levels and preventive practices among health care workers [27]. Another study identified fear as a predictor of behavioral change [28]. The association between worry and adherence in our study could indicate that worry was not overwhelming and that citizens felt in control of risks by respecting restrictions. We cannot exclude that this might have been different with higher anxiety levels.

Considering population subgroups, young adults were often the most anxious despite being less at risk of hospitalization or death [17,18,23,29]. Young people were worried about social isolation and develop depressive symptoms during school closings [30]. In Switzerland, students were concerned about whether they would be able to finish the 2020 university year [31], and lockdowns as well as their socioeconomic consequences were stressful for students [15]. Apart from concerns about the future, young people were not only worried about their own health but also about that of relatives. For example, in a study in Zurich, Switzerland, students were more concerned about the health of their parents and grandparents than their own [32]. Also, our finding of higher worry levels in women echoes several publications [17-19,33]. General factors potentially contributing to worry were the increasing risk of unemployment or loss of income, as well as loneliness and feeling less productive. One-third of respondents had lost part of their income by surveys 2 and 3 (31%, and 34%, respectively), with a slightly better situation in survey 4 (21%). The reported feelings of isolation, loneliness, and being less productive could further contribute to worry in some respondents. For example, studying for exams through online classes only, without any campus life, can be a source of worry compared with when stress from studying and exams is compensated by in-person interactions with teachers and colleagues. Four years after the pandemic, Sayed et al. [34] insist on the importance of addressing mental health of children and young adults during global crises and of recognizing long-term impacts. They further emphasize the need for research and public health prioritization of these important topics.

Overall, our findings are in line with publications that highlight the importance of addressing the many individual and collective aspects that influenced mental health during the COVID-19 pandemic, such as isolation, loneliness, and fear [35]. Many individuals demonstrated remarkable resilience, allowing society to avoid a general increase in loneliness [36]. However, population estimates may mask individual heterogeneity; loneliness is indeed a major public health concern and must be considered as a negative determinant of health [35]. Even though the pandemic is over, we must not forget its long-term effects on mental health and public health authorities should consider the differing impact of governmental decisions on the general population versus on individuals with pre-existing mental health conditions [37]. Our results of the worries of citizens and adherence to pandemic measures can be useful in preparing for future pandemics, for example, in considering criteria for and potential impact of restrictions on different subgroups of the population.

Strengths and Limitations

The strengths of our study were repeated surveys with similar questions and our relatively large sample size, allowing us to examine subgroups of the population.

Concerning limitations, data were collected through the online distribution of surveys in a simple, cost-effective, and feasible way during the rapidly evolving pandemic. Participation was more attractive to women and younger people with higher literacy and education. Also, participation was variable during data collection periods. The participant sample was more representative in the last and longest period (survey 4). This selection and variation need to be considered in the interpretation of our data which are prone to desirability, information, and selection bias. Different distribution channels and methods are probably needed for disadvantaged populations, as we showed in a recent study using our survey in a population of refugees and migrants [38]. Finally, another inherent limitation of our anonymous data collection is that we could not follow a cohort of persons throughout the pandemic.

Conclusion

Worry reached moderate levels and varied with COVID-19 incidence during the pandemic. Higher worry levels were associated with increased self-reported and perceived adherence of others to government restrictions. Younger people and women reported higher worry levels. Authorities should take population worry levels into account in planning and designing pandemic communication. Adapting communication to population subgroups should be considered for future health crises.

Acknowledgments

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Data Availability

The datasets generated during and/or analyzed during this study are available from the corresponding author on reasonable request.

Authors' Contributions

CDL and VK wrote most of the manuscript. CM did most of the statistical analyses and wrote part of the article. SB contributed to analyzing and interpreting data and did part of the statistical analyses. M-AD contributed to designing the study and the questionnaires, collected data, and edited the manuscript. AG contributed to the logistics of the research team, interpreted the data, and edited the manuscript. KS contributed to designing the study and the questionnaires, collected data, and did statistical analyses. CVP was the instigator of the study and contributed to the study and questionnaire design, data collection, and manuscript writing. All authors revised the manuscript for intellectual content and approved it before submission. The authors indicate that they did not use generative artificial intelligence when writing their manuscript.

Conflicts of Interest

M-AD has contributed to the development of Option Grid patient decision aids and receives consulting income from EBSCO Health and royalties. KS receives salary support from the Leenaards Foundation. EBSCO Information Services sells subscription access to Option Grid patient decision aids.

Multimedia Appendix 1
Survey 1.
[PDF File (Adobe PDF File), 362 KB - ijmr_v14i1e55636_app1.pdf]

Multimedia Appendix 2
Survey 2.
[PDF File (Adobe PDF File), 343 KB - ijmr_v14i1e55636_app2.pdf]

Multimedia Appendix 3
Survey 3.
[PDF File (Adobe PDF File), 384 KB - ijmr_v14i1e55636_app3.pdf]

Multimedia Appendix 4
Survey 4.
[PDF File (Adobe PDF File), 370 KB - ijmr_v14i1e55636_app4.pdf]

Multimedia Appendix 5
Linear regression results for three models; all on visual analogue scales from 0 to 100 (0=not at all; 100=in all situations).
[PDF File (Adobe PDF File), 77 KB - ijmr_v14i1e55636_app5.pdf]

Multimedia Appendix 6
Perceived changes of daily life during the first pandemic wave.
[PDF File (Adobe PDF File), 45 KB - ijmr_v14i1e55636_app6.pdf]

Multimedia Appendix 7
Impact of restrictions on daily life, S2, S3, S4.
[PDF File (Adobe PDF File), 40 KB - ijmr_v14i1e55636_app7.pdf]

Multimedia Appendix 8
Concerns of respondents, S3, S4.
[PDF File (Adobe PDF File), 40 KB - ijmr_v14i1e55636_app8.pdf]

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Abbreviations

CHERRIES: Checklist for Reporting Results of Internet e-Surveys
REDCap: Research Electronic Data Capture

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