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Structural validity and measurement invariance of the WHO-5 Well-Being Index among young adolescents in a family-focused prevention context in Southeastern Europe

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Abstract

Background The World Health Organization Five Well-Being Index (WHO-5) is a widely used, open-access measure of subjective well-being. However, evidence on its psychometric properties among younger adolescents participating in preventive interventions in low- and middle-income countries remains limited. This study aims to evaluate the structural validity and cross-country measurement invariance of the WHO-5 among young adolescents participating in a prevention program in Southeastern Europe.

Methods Data were drawn from the baseline assessment of the FLOURISH Phase 2 trial, including 653 adolescents aged 10–14 years recruited with their caregivers as part of a family-focused program in Moldova and North Macedonia. The WHO-5 was administered using culturally adapted versions in local languages. Confirmatory factor analysis tested the one-factor, five-item model in the overall sample and separately in each country. Model fit was evaluated using the RMSEA, CFI, TLI and SRMR. Multi-group ordinal confirmatory factor analysis assessed configural, threshold, metric and scalar invariance across countries. Internal consistency was estimated using McDonald's ω .

Results The one-factor, five-item model showed appropriate fit in the overall sample, CFI=0.995, TLI=0.990, RMSEA=0.069 and SRMR=0.019. Country-specific analyses also supported the one-factor structure. Standardized factor loadings ranged from 0.698 to 0.811 and residual variances ranged from 0.343 to 0.513. McDonald's ω was 0.84. Measurement invariance analyses supported configural, threshold, metric and scalar invariance.

Conclusions The WHO-5 demonstrated good internal consistency, a unidimensional structure, and cross-country measurement invariance among young adolescents participating in a prevention program in Moldova and North Macedonia. These findings support the use of the WHO-5 for assessing and comparing adolescent well-being across these settings and contribute to the validation of open-access, cross-culturally adapted instruments for well-being monitoring in middle-income and prevention contexts.

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Trial registration The parent FLOURISH Phase 2 trial was prospectively registered with ClinicalTrials.gov (NCT06562244). The published trial protocol is available at <https://doi.org/10.1136/bmjopen-2024-094085>. Project page: <https://www.flourish-study>.

Keywords WHO-5 · Well-being · Adolescents · Psychometrics · Southeastern Europe

Background

Adolescence is a critical developmental stage marking the transition from childhood to adulthood, characterized by biological, cognitive and socioemotional changes.[1] Successful adaptation to these developmental changes is essential for laying the basis for lifelong health, with well-being playing a central role in this process.[2] Well-being is a complex construct that has been defined as a positive state extending beyond the absence of disease or distress and involving flourishing, positive functioning and engagement in daily life.[3] Higher levels of well-being during adolescence have been consistently associated with favorable outcomes, including stronger academic engagement, better social adjustment and a reduced risk of later psychological difficulties.[4, 5] At the same time, adolescent well-being is strongly influenced by social and structural conditions. In low- and middle-income countries (LMICs), adolescents often experience additional challenges related to economic hardship, social inequalities, and limited access to mental health services, which may compromise well-being and developmental opportunities.[6] This is particularly relevant in Southeastern European LMICs such as the Republic of Moldova (henceforth Moldova) and the Republic of North Macedonia (henceforth North Macedonia), where structural constraints may increase vulnerability during adolescence[7].

Reliable, valid and culturally appropriate assessment tools are therefore essential for accurately monitoring adolescent well-being and informing evidence-based policy development, particularly during early adolescence, when identifying emerging difficulties can facilitate timely preventive intervention[8, 9].

The World Health Organization Five Well-Being Index (WHO-5) is one of the most widely used instruments to assess subjective well-being. It is a brief, freely available self-report measure assessing positive mood, vitality, and general interest in life.[10] Originally developed for use in adult populations, the WHO-5 has been translated into more than 30 languages and has demonstrated excellent psychometric properties, especially in Western, educated, industrialized, rich and democratic (WEIRD) populations.[11–13] Subsequently, the instrument has also been applied to younger populations, including adolescents, although psychometric investigations in this age group remain comparatively fewer. Available studies on adolescents generally reported good internal consistency, convergent validity and support for a unidimensional WHO-5 structure, with most analyses retaining all five items[14–22], although one study proposed a four-item variant.[23] Two studies additionally examined cross-national measurement invariance and found support for configural and metric models, but not full scalar equivalence[21,23], suggesting that the functioning of the WHO-5 may vary across countries and sociocultural contexts in youth populations.

Overall, existing research indicates that the WHO-5 is a promising measure of well-being in adolescent populations. However, previous studies regarding its dimensional structure and cross-group comparability have predominantly focused on older adolescents in WEIRD settings, with limited attention to young adolescents and LMICs. The present study aimed to examine the structural validity and measurement invariance of the WHO-5 Well-Being Index among adolescents aged 10 to 14 years participating in a family-focused preventive intervention trial in Moldova and North Macedonia. Confirming the factor structure and establishing measurement invariance of the WHO-5 across these settings is critical as this would provide evidence that the instrument measures well-being comparably in populations beyond those in which it was originally developed. Furthermore, such evidence would provide local researchers and practitioners with a freely available and culturally appropriate instrument for assessing and monitoring adolescent well-being.

Methods

Study setting and participants

Data for this study were drawn from the baseline assessment of FLOURISH Phase 2, a multicountry cluster factorial trial conducted among young adolescents and their primary caregivers in Moldova and North Macedonia. [24] The trial evaluated three intervention components to inform the development of an optimized family-focused intervention promoting adolescent mental health and well-being. Eligible adolescents were aged 10–14 years, lived with a participating caregiver for at least four nights per week, and were able to complete questionnaires in Macedonian or Romanian. Exclusion criteria were limited to significant psychiatric, cognitive, or physical health conditions or acute distress that could interfere with participation. The sample size for the present psychometric study was determined for the parent FLOURISH Phase 2 trial[24].

The trial was implemented through the Institute for Marriage, Family and Systemic Practice (ALTERNATIVA) in North Macedonia and the Health for Youth Association (HYA) in Moldova. Because the trial also aimed to inform future implementation and scale-up within existing service systems, recruitment pathways were based on each organization's established service-delivery infrastructure and community networks. Participants were recruited primarily through schools in North Macedonia and through youth-friendly health services in Moldova. Recruitment followed a proportionate universalism approach, which meant that recruitment teams made outreach efforts to encourage the participation of adolescents and families considered to be at greater risk for psychosocial or socioeconomic vulnerability. The resulting participants constituted a convenience sample relative to the eligible adolescent population in each country.

Baseline data were collected before the start of the intervention using computer-assisted self-report questionnaires completed on tablets with the support of trained data assessors. Adolescents completed the questionnaires in a confidential setting separately from their caregivers. The same administration procedures were followed in both countries.

Instruments

Adolescent well-being was assessed using the World Health Organization Five Well-Being Index (WHO-5), a brief self-report measure designed to evaluate subjective well-being over the past two weeks.[10] The WHO-5 consists of five positively worded items, reflecting central aspects of well-being: positive mood (e.g., *"I have felt cheerful and in good spirits"*), vitality (e.g., *"I have felt active and vigorous"*), and general interest in life (e.g., *"My daily life has been filled with things that interest me"*). Responses are rated on a six-point Likert scale ranging from 0 (*"At no time"*) to 5 (*"All of the time"*), with higher scores indicating greater well-being. Cutoff-based scores of the instrument were not examined, as this was outside the scope of the present study.

The WHO-5 was administered in Macedonian and Romanian, using versions developed through a rigorous cultural adaptation and translation process, which has been reported elsewhere.[25] In brief, this procedure included evaluation of the cultural relevance of the items, forward and back-translation by bilingual mental health professionals, assessment of semantic equivalence, expert review, and pilot testing with adolescents in both countries. Furthermore, qualitative think-aloud interviews were conducted to ensure linguistic clarity and conceptual equivalence, resulting in final versions that were both culturally appropriate and easily understood by adolescents.

Data analysis

The present psychometric evaluation was conducted as a secondary analysis of Phase 2 of FLOURISH.[24] Sociodemographic characteristics were summarized for the overall sample and by country. Given the ordinal response format of the WHO-5 items, item-response distributions were examined using frequencies, and inter-item associations were evaluated using polychoric correlations.

Confirmatory factor analysis (CFA) was conducted to examine the hypothesized one-factor, five-item structure of the WHO-5. [26] The model was evaluated in the overall sample and separately in the North Macedonian and Moldovan subsamples. Models were estimated using weighted least squares mean- and variance-adjusted estimation (WLSMV). Model fit was evaluated using the scaled χ^2 statistic, comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR). Values of CFI and TLI ≥ 0.95 and RMSEA and SRMR ≤ 0.08 were considered indicative of acceptable model fit. [27] Although the scaled χ^2 statistic was reported, model evaluation was based primarily on the approximate fit indices because the χ^2 test assesses exact model fit and is highly sensitive to sample size, often yielding statistically significant results when model misfit is small.

To investigate potential sources of local misfit in the models, modification indices (MIs) and expected parameter changes (EPCs) were examined. [26,28] MIs indicate the extent to which model fit would be expected to improve if a fixed parameter were freely estimated, whereas EPCs indicate the expected magnitude of the corresponding parameter change. In this one-factor model, these diagnostics were used to identify potentially omitted residual correlations. Internal consistency was estimated using McDonald's ω . [29]

After the one-factor measurement model had been evaluated in the overall and country-specific samples, measurement invariance of the WHO-5 across Moldova and North Macedonia was examined using a sequence of multigroup ordinal CFA models. Models were estimated using WLSMV with the theta parameterization and the Wu–Estabrook identification approach for ordered categorical indicators [30]. Invariance was tested sequentially at four levels. The configural model specified the same factor structure across countries. Equality constraints were then imposed on item thresholds (threshold invariance), factor loadings in addition to thresholds (metric invariance) and item intercepts in addition to thresholds and loadings (scalar invariance).

Nested models were compared using scaled χ^2 difference tests based on the Satorra method [31] and changes in the scaled CFI, TLI, and RMSEA and in the SRMR. Invariance was evaluated primarily using changes in CFI and RMSEA. A decrease in CFI of ≤ 0.010 and an increase in RMSEA of ≤ 0.015 were considered supportive of invariance. [32] Changes in TLI and SRMR were examined as supplementary indicators.

After scalar invariance had been established, latent mean differences were estimated with North Macedonia specified as the reference group, for which the latent factor mean was fixed at 0 and its variance was fixed at 1. The estimated latent mean for Moldova therefore represented the difference between Moldova and North Macedonia, expressed relative to the North Macedonian latent-factor standard deviation. Equality of the latent means was evaluated by comparing the scalar model with a model that additionally constrained the latent means to equality.

All analyses were conducted in RStudio, [33] using R [34], with the lavaan and semTools packages used for the CFA and measurement-invariance analyses. [35].

This study is reported in accordance with the COSMIN Reporting Guideline for Studies on Measurement Properties of Patient-Reported Outcome Measures, version 2.0, [36] with the completed checklist provided in the Supplementary Material.

Results

Sample

Participant characteristics are reported in Table 1. The sample comprised 653 adolescents aged 10–14 years ($M=11.90$, $SD=1.29$), including 331 participants from North Macedonia and 322 from Moldova. Age was broadly similar across North Macedonia ($M=11.73$, $SD=1.30$) and Moldova ($M=12.08$, $SD=1.25$), as were gender distributions. Overall, 50.5% of participants were male ($n=330$), 49.2% were female ($n=321$) and 0.3% identified as diverse ($n=2$). Most participants were currently attending school in both North Macedonia (99.7%) and Moldova (97.8%). Eastern Orthodox was the predominant religion in both countries (Table 1).

Table 1 Sociodemographic characteristics in the overall sample and by country

Characteristic	Category	Overall (N=653)	North Macedonia (n=331)	Moldova (n=322)
Age (years)	Mean (SD)	11.90 (1.29)	11.73 (1.30)	12.08 (1.25)
Gender, n (%)	Male	330 (50.5)	168 (50.8)	162 (50.3)
	Female	321 (49.2)	163 (49.2)	158 (49.1)
	Diverse	2 (0.3)	0 (0.0)	2 (0.6)
Attending school, n (%)	Yes	645 (98.8)	330 (99.7)	315 (97.8)
	No	8 (1.2)	1 (0.3)	7 (2.2)
Ethnicity, n (%)	Macedonian	317 (48.5)	315 (95.2)	2 (0.6)
	Moldovan	297 (45.5)	0 (0.0)	297 (92.2)
	Romanian	21 (3.2)	1 (0.3)	20 (6.2)
	Other	17 (2.6)	15 (4.5)	2 (0.6)
	Refused to answer	1 (0.2)	0 (0.0)	1 (0.3)
Religion, n (%)	Eastern Orthodox	573 (87.7)	295 (89.1)	278 (86.3)
	Islam	12 (1.8)	9 (2.7)	3 (0.9)
	Catholic	5 (0.8)	4 (1.2)	1 (0.3)
	Other	20 (3.1)	5 (1.5)	15 (4.7)
	Refused to answer	43 (6.6)	18 (5.4)	25 (7.8)

Table 2 Confirmatory factor analysis of the one-factor, five-item WHO-5 model overall and by country

Sample	n	χ^2	df	p	CFI	TLI	RMSEA	SRMR
Overall	653	20.697	5	0.001	0.995	0.990	0.069 (0.040, 0.102)	0.019
North Macedonia	331	16.813	5	0.005	0.992	0.983	0.085 (0.042, 0.131)	0.026
Moldova	322	5.593	5	0.348	1.000	0.999	0.019 (0.000, 0.082)	0.014

χ^2 chi-square test statistic, df degrees of freedom, CFI comparative fit index, TLI Tucker–Lewis index, RMSEA root mean square error of approximation, SRMR standardized root mean square residual. Values in parentheses are 90% confidence intervals for RMSEA

Psychometric characteristics

All response categories were endorsed for every WHO-5 item, and there were no missing data. Responses generally showed greater endorsement of the upper categories, although the distribution varied across items (Table S1). Polychoric correlations among the items ranged from 0.496 to 0.611 (Table S2).

Table 2 shows the fit statistics for the one-factor, five-item WHO-5 model in the overall sample and separately by country. The overall and country-specific CFA models each had five degrees of freedom. In the overall sample, model fit was $\chi^2(5)=20.697$, $p=0.001$, CFI=0.995, TLI=0.990, RMSEA=0.069, 90% CI [0.040, 0.102] and SRMR=0.019.

The country-specific models generally supported the one-factor structure. The fit was excellent in Moldova. In North Macedonia, the CFI, TLI, and SRMR indicated good fit, whereas the RMSEA was slightly above the prespecified cutoff (RMSEA=0.085, 90% CI [0.042, 0.131]).

Table 3 shows the standardized factor loadings and residual variances in the overall sample. Standardized factor loadings ranged from 0.698 to 0.811, and standardized residual variances ranged from 0.343 to 0.513. McDonald's ω was 0.84. Inspection of MI and EPC did not identify any substantial residual correlations.

Table 4 shows the fit statistics for the multi-group ordinal CFA models as well as the comparisons between measurement-invariance models. The configural model fitted the data well, $\chi^2(10)=22.879$, $p=0.011$, CFI=0.996, TLI=0.992, RMSEA=0.063, 90% CI [0.029, 0.097] and SRMR=0.020, supporting the same one-factor structure across countries. Constraining item thresholds to equality also resulted in good fit, $\chi^2(25)=41.650$, $p=0.020$, CFI=0.995, TLI=0.996, RMSEA=0.045, 90% CI [0.018, 0.069] and SRMR=0.020. The metric model, which constrained item thresholds and factor loadings to equality, continued to show good fit, $\chi^2(29)=41.399$, $p=0.064$, CFI=0.996, TLI=0.997, RMSEA=0.036, 90% CI [0.000, 0.060] and SRMR=0.022. The scalar model, which additionally constrained item intercepts to equality, also demonstrated good fit, $\chi^2(33)=49.397$, $p=0.033$,

Table 3 Standardized factor loadings and residual variances

Item		Loading	Residual Variance
1.	I have felt cheerful and in good spirits	0.751 (0.710, 0.791)	0.436 (0.376, 0.497)
2.	I have felt calm and relaxed	0.750 (0.712, 0.788)	0.438 (0.381, 0.495)
3.	I have felt active and vigorous	0.811 (0.776, 0.845)	0.343 (0.287, 0.399)
4.	I woke up feeling fresh and rested	0.726 (0.686, 0.767)	0.472 (0.413, 0.531)
5.	My daily life has been filled with things that interest me	0.698 (0.653, 0.743)	0.513 (0.450, 0.575)

Values in parentheses are 95% confidence intervals

Table 4 Multi-group confirmatory factor analysis and measurement invariance comparisons

Model fit							
Model	χ^2	df	p	CFI	TLI	RMSEA	SRMR
Configural	22.879	10	0.011	0.996	0.992	0.063 (0.029, 0.097)	0.020
Threshold	41.650	25	0.020	0.995	0.996	0.045 (0.018, 0.069)	0.020
Metric	41.399	29	0.064	0.996	0.997	0.036 (0.000, 0.060)	0.022
Scalar	49.397	33	0.033	0.995	0.997	0.039 (0.011, 0.061)	0.021
Comparisons between models							
Comparison	$\Delta\chi^2$	Δdf	p	ΔCFI	ΔTLI	$\Delta RMSEA$	$\Delta SRMR$
Threshold vs. Configural	20.732	15	0.146	-0.001	0.004	-0.018	0.000
Metric vs. Threshold	3.512	4	0.476	0.001	0.001	-0.009	0.002
Scalar vs. Metric	7.658	4	0.105	-0.001	0.000	0.003	-0.001

χ^2 chi-square test statistic, *df* degrees of freedom, *CFI* comparative fit index, *TLI* Tucker–Lewis index, *RMSEA* root mean square error of approximation, *SRMR* standardized root mean square residual, Δ change relative to the preceding model. Values in parentheses are 90% confidence intervals for RMSEA

CFI=0.995, TLI=0.997, RMSEA=0.039, 90% CI [0.011, 0.061] and SRMR=0.021. Scaled chi-square difference tests were nonsignificant for the threshold versus configural comparison, $\Delta\chi^2(15)=20.732$, $p=0.146$; the metric versus threshold comparison, $\Delta\chi^2(4)=3.512$, $p=0.476$; and the scalar versus metric comparison, $\Delta\chi^2(4)=7.658$, $p=0.105$. Changes in the approximate fit indices were also small and within the prespecified criteria.

Following the establishment of scalar invariance, latent means were compared. Adolescents in Moldova had a significantly lower latent well-being mean than adolescents in North Macedonia (estimate = -0.346, SE = 0.092, $p < 0.001$, 95% CI [-0.525, -0.166]). Constraining the latent means to equality significantly worsened model fit, $\Delta\chi^2(1)=13.861$, $p < 0.001$.

Discussion

This study examined the structural validity and cross-country measurement invariance of the WHO-5 Well-Being Index among young adolescents from Moldova and North Macedonia. Extending previous research, the study provides evidence on the performance of the WHO-5 among youth participating in a universal prevention study in two LMIC settings. Confirmatory factor analyses supported a unidimensional factor structure in both the pooled sample and each country separately. Multi-group ordinal confirmatory factor analysis supported configural, threshold, metric and scalar invariance across countries, indicating that the WHO-5 measures the latent subjective well-being construct comparably across the two settings and allowing latent mean comparisons.

Consistent with prior studies, the WHO-5 demonstrated good internal consistency, indicating that the items reliably capture a coherent underlying construct of well-being. Concerning structural validity, the results of our study corroborated the unidimensional structure of the WHO-5, with all five items loading adequately on a single latent factor. This finding is in line with previous research supporting the one-factor, five-item model of the instrument across adolescent populations with chronic conditions, such as type 1 diabetes [18], as well as in general

school-based samples[16–17, 19–22] and clinical settings.[15] These results thus indicate that the latent structure of the WHO-5 is also consistent among younger adolescents within prevention-oriented settings.

Measurement invariance analyses supported configural, threshold, metric and scalar invariance of the WHO-5 across Moldova and North Macedonia, indicating invariance of the one-factor structure, item thresholds, factor loadings and item intercepts. These findings are partially consistent with previous research[21, 23] which established configural and metric invariance but did not support full scalar invariance in larger multi-country samples. One possible explanation for this discrepancy is the greater cross-national heterogeneity in previous studies, as the inclusion of more culturally and linguistically diverse countries may increase the likelihood of differential item interpretation among adolescents. Conversely, the scalar invariance observed in the present study may be due, at least in part, to its focus on two geographically and culturally closer Southeastern European countries and to the comprehensive process of cross-cultural adaptation and translation used to develop the WHO-5 versions.[25] The establishment of scalar invariance supports the cross-country comparability of latent WHO-5 well-being in North Macedonia and Moldova, allowing its use as a common metric for monitoring adolescent well-being and evaluating preventive programs across similar cultural settings. The FLOURISH project, [24] which evaluates a universal family-focused prevention program, exemplifies this application, with the WHO-5 serving as a key outcome measure for assessing and comparing adolescent well-being across both countries.

Building on the established scalar invariance, we compared latent well-being means between the two countries. Adolescents in Moldova exhibited significantly lower average latent well-being than their counterparts in North Macedonia. This difference may partly be attributable to differences in recruitment context, since North Macedonian participants were recruited through schools while the Moldovan sample drew from youth-friendly primary healthcare services. Consequently, the Moldovan sample may have included a greater proportion of adolescents with lower well-being, although the study design does not allow determining whether this reflects true population differences or sampling-related selection effects.

This research has some limitations. The study focused on convenience samples of young adolescents recruited primarily through schools in North Macedonia and youth-friendly health services in Moldova. Although the WHO-5 functioned comparably across the two samples, the invariance findings may not generalize to the national adolescent populations, and the lower latent well-being observed in Moldova may partly reflect differences in recruitment. Furthermore, older adolescents and those assessed in other contexts may interpret WHO-5 items differently due to greater autonomy and more differentiated emotional experiences, potentially affecting item functioning and measurement equivalence. Lastly, only country-level invariance was examined; invariance across age subgroups within the 10–14 year range and across gender groups was not assessed. Future research should directly test age- and context-related differences in WHO-5 item functioning to determine whether these measurement properties hold across age groups and recruitment settings. In addition, future studies may apply complementary psychometric approaches, such as item response theory, to further examine item functioning and measurement precision across the well-being continuum. Finally, the present study provides evidence limited to the internal structure, internal consistency and cross-country measurement invariance of the WHO-5. Other sources of validity evidence, including convergent, discriminant and criterion-related validity, as well as temporal stability, were not examined and should be evaluated in future research.

Conclusions

Overall, the findings support the WHO-5 as an internally consistent and structurally valid measure of subjective well-being among young adolescents participating in a family-focused universal prevention program in Moldova and North Macedonia. The scale demonstrated a stable unidimensional structure and configural, threshold, metric and scalar invariance across the two countries, indicating that it functions comparably across these contexts and supports meaningful cross-country comparisons of latent well-being.

By establishing these properties in early adolescence and within a universal prevention context, the present study extends the applicability of the WHO-5 beyond general population surveys and clinical samples to settings where mental health promotion and early intervention are central. This is particularly relevant for LMICs, where brief, culturally adapted, and freely accessible instruments are essential for strengthening research, surveillance, and evaluation capacities in global adolescent well-being.

Abbreviations

CFI	Comparative Fit Index
CFA	Confirmatory Factor Analysis
CI	Confidence Interval
EPC	Expected Parameter Change
LMICs	Low- and Middle-Income Countries
MI	Modification Index
RMSEA	Root Mean Square Error of Approximation
SD	Standard Deviation
SRMR	Standardized Root Mean Square Residual
TLI	Tucker–Lewis Index
WHO-5	World Health Organization Five Well-Being Index
WLSMV	Weighted Least Squares Mean and Variance Adjusted
ω	McDonald's Omega

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1186/s40359-026-05624-w>.

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Author contributions AP, FW, IK, MR and HMF contributed to data collection. AP, YS and HMF conceptualized the study. AP conducted statistical analysis. AP drafted the manuscript, with contributions from all authors. All authors contributed to the critical revision of the manuscript and approved the final version.

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Data availability The data used in the present study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate The study was reviewed and approved by three institutional ethics committees: the Institutional Review Board for Research Ethics of the University of Klagenfurt, Austria (approval no. 2023-013); the Ethical Commission for Human Research of the Medical Faculty, St. Cyril and Methodius University, North Macedonia (approval no. 03-2144/4); and the National Committee of Ethical Expertise for Clinical Trials of the Ministry of Health, Republic of Moldova (approval no. 1476). All study procedures adhered to the principles of the Declaration of Helsinki and relevant national regulations. The study included adolescents aged 10–14 years. Written informed consent for adolescents' participation was obtained from their caregivers. In Moldova, adolescents aged 10–14 years also provided assent to participate; in North Macedonia, adolescents aged 10–13 years provided assent, and adolescents aged 14 years additionally provided their own written consent in accordance with national ethical requirements.

Competing interests The authors declare no competing interests.

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