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The role of health literacy in boosting citizen engagement in appropriate use of antibiotics

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ABSTRACT

Background: Antimicrobial resistance (AMR) represents a growing challenge to both individual and public health, driven by the excessive and inappropriate use of antibiotics. Studies emphasize a widespread lack of knowledge regarding proper antibiotic use and the mechanisms of antibiotic resistance. This study aims to explore the relationships between citizens' health engagement and attitudes towards antibiotic consumption (Hypothesis 1, Hypothesis 2) and explores the role of orientation to health literacy as a mediator of these relationships (Hypothesis 3).

Methods: Data were collected via a questionnaire administered to a representative sample of the Italian population ($N = 1016$). Descriptive statistics and mediation analysis, using bootstrapping with 5000 resamples to estimate indirect effects and assess statistical significance.

Results: All hypotheses were confirmed. Health engagement had a significant, positive effect on orientation to health literacy, which was positively associated with attitudes towards antibiotic consumption. Moreover, orientation to health literacy fully mediated the effect of health engagement on attitudes towards antibiotic consumption.

Conclusions: This study highlights the crucial role of health literacy in influencing attitudes towards appropriate antibiotic consumption. Public health interventions should not only encourage individuals to actively engage with their health, but also focus on improving their health literacy, including on specific topics such as AMR.

Keywords: antibiotic consumption; antimicrobial resistance; behaviour change; citizen engagement

Introduction

Antimicrobial resistance (AMR) is a growing public health challenge, undermining treatment efficacy for bacterial infections and increasing morbidity, mortality, and healthcare costs.[1,2] The World Health Organization (WHO) identifies AMR as a major global health threat. Annually, 4.71 million deaths are linked to antibiotic-resistant infections,[2] with projections estimating 10 million deaths annually by 2050. Between 2025 and 2050, AMR may cause 39.1 million deaths and be associated with an additional 169 million.[3]

A key driver is the excessive and inappropriate use of antibiotics,[4] which fosters resistant bacterial strains. Inappropriate consumption includes overprescribing and improper consumer behaviours[5] such as altering dosages, ending treatments when they feel better and failing to respect administration schedules. Self-medication and using left-over antibiotics are common practices that contribute to resistance.[6]

Studies highlight widespread misconceptions and limited knowledge regarding the effective use of antibiotics and the mechanisms of AMR.[7–9] Many believe antibiotics treat colds, flu, or viral infections. In Italy, prescription rates for these conditions are high: exceeding 30% for pharyngitis and tonsillitis, 25% for the treatment of influenza, colds, acute laryngotracheitis and uncomplicated cystitis, and over 20% for acute

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bronchitis.[10] Studies also highlight limited public knowledge about AMR.[11,12] A study conducted in Italy[13] showed a significant portion of the population reported self-medicating with antibiotics, and many expressed a willingness to take antibiotics without a prescription.

These findings show a critical gap in public knowledge, reflecting low health literacy on antibiotic use. Addressing this gap is crucial not only for individual health, but also for facing AMR. Efforts must also raise public awareness and foster informed, responsible behaviour.

To effectively tackle these misconceptions, it is essential to investigate the psychological and cognitive factors influencing antibiotic-related behaviours. Research highlights the importance of health engagement and health literacy in raising awareness and promoting healthy behaviours.[14]

Health engagement reflects how actively individuals manage their health.[15] Engaged citizens are more likely to seek accurate information,[16] adhere to medical guidelines,[17] make informed decisions,[18] and understand health risks.[19] Moreover, health engagement influences attitudes towards health behaviours, which are important predictors of actual behaviours.[20]

Health literacy refers to individuals' ability to access, understand, and use health information to take informed decisions.[21] It influences how people interpret and act upon medical advice, including antibiotic use.[22] Beyond cognitive aspects, it is also important to consider the motivational and dispositional dimensions that shape how individuals engage with health information. In this scenario, the orientation to health literacy becomes relevant. This construct refers to an individual's proactive approach to seeking health information, to reflect critically on the information, driven by a desire to engage with health behaviours.[23] This orientation has been shown to positively influence health-promoting behaviours, suggesting that citizens who actively seek health information are also more likely to adopt healthy behaviours.[24]

While health engagement drives individuals to act regarding their health, orientation to health literacy may determine whether individuals are motivated to seek, process, and use information to make appropriate choices. Despite extensive research on the clinical and epidemiological aspects of AMR, less is known about how health literacy and health engagement interact to influence attitudes towards the appropriate use of antibiotics. Investigating this relationship could help design more effective interventions aimed at reducing inappropriate antibiotic use.

This study aims to explore the relationships between citizens' health engagement and attitudes towards antibiotic consumption, and the mediating role of orientation to health literacy.

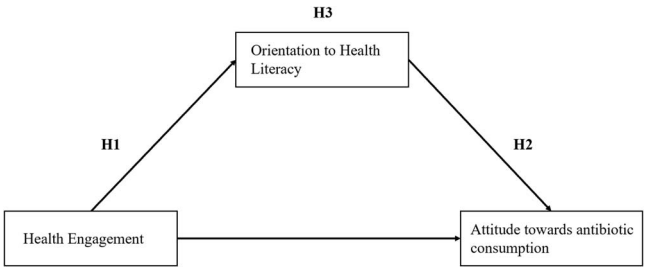

Figure 1 Research hypotheses (H1: Health engagement is positively related to the orientation to health literacy; H2: Orientation to health literacy is positively related to attitudes towards appropriate consumption of antibiotics; H3: Orientation to health literacy mediates the relationship between health engagement and attitudes towards appropriate consumption of antibiotics).

We hypothesize (Fig. 1):

(H1): Health engagement is positively related to the orientation to health literacy.

(H2): Orientation to health literacy is positively related to the attitudes towards appropriate consumption of antibiotics.

(H3): Orientation to health literacy mediates the relationship between health engagement and attitudes towards appropriate consumption of antibiotics.

Methods

Procedure and sample

A questionnaire was completed by a representative sample of the Italian population ($N = 1016$), aged 18–70 years old, stratified by demographics according to the Italian National Institute of Statistics (ISTAT). All participants provided informed consent before taking part in this research. The survey was conducted in 2023 using a CAWI (computer-assisted web interviewing) methodology, supported by the panel provider Norstat s.r.l. and approved by an independent ethics committee of Università Cattolica del Sacro Cuore, in Milan (CERPS).

Measures

Sociodemographic characteristics were collected. The questionnaire included the following variables:

- Attitude towards antibiotic consumption: assessed through 5 items on a 5-point Likert scale (1 = completely disagree, 5 = completely agree). An example item is: 'People should only take antibiotics when a doctor prescribes them'. Higher score indicates a stronger adoption of responsible antibiotic use and preventive health behaviours, such as limiting antibiotics to medically necessary situations, encouraging responsible behaviour among both citizens and healthcare professionals, and reducing antibiotics in animal farming.

- Health engagement: measured by ad hoc items on a 5-point Likert scale (1 = completely disagree, 5 = completely agree). Although validated scales are available in the literature, we opted to develop ad hoc items to capture the specific dimensions of interest for this study. We aimed to assess perceived self-efficacy in health management, emotional readiness to engage in health-related behaviour even under stress, and proactive attitude towards collaboration with healthcare professionals. An example is: 'Even under stress, I manage to take care of my health'. High level of health engagement suggests that individuals are more likely to invest time in seeking health information, communicate with professionals about their health concerns, and prioritize collaboration with healthcare providers.
- Orientation to health literacy: 6 ad hoc items, rated on a 7-point Likert scale (1 = completely disagree, 7 = completely agree). This construct assesses motivation to engage with health-related information and the perceived need to stay informed. Existing tools, such as the Health Literacy Questionnaire[25] or the European Health Literacy Survey Questionnaire (HLS-EU-Q),[26] primarily assess perceived abilities to access, understand, and apply health information, while the Health Information Orientation Scale[27] focuses on information-related beliefs and behaviours. However, none of these tools fully capture the multidimensional nature of the construct we aimed to investigate. In our framework, orientation to health literacy encompasses not only perceived confidence in one's cognitive ability to obtain, understand, evaluate, and use health information, but also the intrinsic motivation to stay informed. To our knowledge, no existing scale integrates the cognitive, emotional, and behavioural components of engagement with health information. Therefore, we developed items that reflect this complexity while keeping the scale concise. An example is: 'I need to keep myself informed'. Higher scores reflect a proactive orientation towards accessing and using health information, including confidence in identifying reliable sources and discerning fake news.

Data analysis

Descriptive statistics (mean, median, standard deviation, skewness, kurtosis) were computed for each item. All these analyses were performed with SPSS (IBM SPSS Statistics 29.0.1.0). Normality was tested through skewness and kurtosis values: as suggested for large samples (>300), skewness within an absolute value of 2 and kurtosis of 3 indicate a normal distribution.[28] Reliability was evaluated using the Omega coefficient, with values above 0.70 considered acceptable.[29] Pearson correlation coefficients were calculated to examine the associations between items and assess internal consistency. Exploratory factor analysis (EFA) was then performed for each of the three constructs to determine whether they were unidimensional, using principal component extraction and varimax rotation. To determine the number of potential underlying factors, we applied the following criteria: eigenvalues > 1, scree plot, parallel analysis, factor loadings $>|0.40|$, and plausibility of the factors in terms of their substantive meaning.[30]

A mediation analysis was conducted using bootstrapping with 5000 resamples to estimate indirect effects and assess statistical significance. The mediation analysis was performed with the jAMM module of jamovi 2.6.11.[31,32]

Results

Sample characteristics

The sample is composed of Italians citizen, 498 (49.0%) are male and 518 (51.0%) are female, aged between 18 and 70 (M = 47.6; SD = ±13.7). For further details, see Supplementary Materials (Table S1).

Measurement model

Orientation to health literacy and health engagement were normally distributed, while attitudes towards antibiotic consumption slightly deviated from the cut-off values. Since bootstrapping is a robust method, this deviation does not affect the validity of the analysis[33] (Table 1). Inter-item correlations supported internal consistency (Supplementary Materials, Table S2–S4).

EFA confirmed the unidimensionality of all constructs (Table 2). We examined the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy, the determinant of the correlation matrix, and Bartlett's test of sphericity for each construct. The results indicated that data met the criteria for factor analysis, with KMO values greater than 0.60,[34] suggesting adequate sampling adequacy. Additionally, Bartlett's test of sphericity was all significant, indicated that item correlations were of an acceptable magnitude for EFA. The determinant of the correlation matrix did not indicate any problem with multicollinearity among the items (determinant $\neq 0$). McDonald's Omega (ω) coefficient indicated high internal consistency for 'attitudes toward antibiotic consumption' (ω = 0.898), 'health engagement' (ω = 0.789), and 'orientation to health literacy' (ω = 0.867).

Descriptive analysis

The distribution of the Italian population shows a positive attitude towards the appropriate use of antibiotics (M = 4.38; SD = 0.70), with 65.3% of participants (n = 663) scoring

Table 1 Descriptive statistics of items.

Item	*M*	*SD*	*Md*	*A*	*K*
Orientation to health literacy_item 1	5.60	1.31	6.00	−0.871	0.520
Orientation to health literacy_item 2	5.77	1.25	6.00	−0.979	0.744
Orientation to health literacy_item 3	5.32	1.28	5.00	−0.643	0.281
Orientation to health literacy_item 4	5.15	1.21	5.00	−0.398	0.311
Orientation to health literacy_item 5	5.54	1.20	6.00	−0.687	0.235
Orientation to health literacy_item 6	5.42	1.31	6.00	−0.588	−0.0659
Orientation to health literacy_total score	5.47	0.98	5.50	−0.448	−0.225
Health engagement_item1	3.39	0.915	3.00	−0.217	−0.313
Health engagement_item2	3.55	0.822	4.00	−0.504	0.167
Health engagement_item3	3.39	1.06	4.00	−0.490	−0.317
Health engagement_item4	3.51	1.01	4.00	−0.708	0.119
Health engagement_item5	4.00	0.800	4.00	−0.840	1.13
Health engagement_total score	3.57	0.674	3.60	−0.43	0.27
Attitude towards antibiotic consumption_item 1	4.38	0.824	5.00	−1.12	0.456
Attitude towards antibiotic consumption_item 2	4.36	0.787	5.00	−0.979	0.189
Attitude towards antibiotic consumption_item 3	4.41	0.820	5.00	−1.30	1.25
Attitude towards antibiotic consumption_item 4	4.42	0.828	5.00	−1.26	0.853
Attitude towards antibiotic consumption_item 5	4.33	0.881	5.00	−1.10	0.407
Attitude towards antibiotic consumption_total score	4.39	0.697	4.60	−1.12	0.497

Table 2 Exploratory factor analysis for attitude towards antibiotic consumption, health engagement, and orientation to health literacy (N = 1016) and McDonald's Omega coefficient.

Factors	*Items*	*Factor loadings*	*ω*
Attitude towards antibiotic consumption	Attitude towards antibiotic consumption_item 1	0.769	0.898
	Attitude towards antibiotic consumption_item 2	0.823	
	Attitude towards antibiotic consumption_item 3	0.812	
	Attitude towards antibiotic consumption_item 4	0.832	
	Attitude towards antibiotic consumption_item 5	0.758	
Health engagement	Health engagement_item 1	0.556	0.789
	Health engagement_item 2	0.475	
	Health engagement_item 3	0.808	
	Health engagement_item 4	0.808	
	Health engagement_item 5	0.545	
Orientation to health literacy	Orientation to health literacy_item 1	0.734	0.867
	Orientation to health literacy_item 2	0.769	
	Orientation to health literacy_item 3	0.705	
	Orientation to health literacy_item 4	0.644	
	Orientation to health literacy_item 5	0.776	
	Orientation to health literacy_item 6	0.693	

above the mean, indicating a strong inclination towards responsible use. Health engagement levels were moderate (M = 3.57; SD = 0.67) with 57.6% (n = 585) scoring above the mean. Orientation to health literacy was also moderate (M = 5.47; SD = 0.98), though 51.0% of respondents (n = 518) scored below the mean (Supplementary Material, Table S5). We also investigated whether there were differences in responses according to main socio-demographic characteristics. The t-test revealed that females scored significantly higher than males in attitudes towards antibiotic consumption ($P < .001$), whereas no gender differences emerged for health engagement and orientation to health literacy. A one-way

Table 3 Standardized indirect effect of the model.

Effect	*Estimate*	*SE*	*Bootstrapping 95% CI*	
			Lower	*Upper*
Indirect				
Health engagement ➔ Orientation to health literacy ➔ Attitude towards antibiotic consumption	0.1352	0.0164	0.1030	0.1673
Component				
Health engagement ➔ Orientation to health literacy	0.4287	0.0433	0.3437	0.5136
Orientation to health literacy ➔ Attitude towards antibiotic consumption	0.3153	0.0211	0.2740	0.3567
Direct				
Health engagement ➔ Attitude towards antibiotic consumption	−0.0107	0.0305	−0.0705	0.0492
Total				
Health engagement ➔ Attitude towards antibiotic consumption	0.1245	0.0322	0.0613	0.1877

Mediator: orientation to health literacy; indirect effect estimated using 5000 bootstrap samples; SE = standard error.

ANOVA showed significant age differences for both attitude towards antibiotic consumption ($P < .001$) and orientation to health literacy ($P < .001$), with older adults (over 55) reporting higher scores than younger groups (18–34 and 35–54). No age-related differences were observed for health engagement. Finally, education level had a significant effect only on orientation to health literacy ($P < .05$), indicating that people with a university degree show higher scores than people with lower levels of education. All analyses are reported in the Supplementary Material (Table S6–S14).

The mediation model

To verify the mediating role of orientation to health literacy, percentile bootstrapping was performed (95% CI, 5000 bootstrap samples).[35] Following the suggestions of Preacher and Hayes,[36] the confidence interval of the lower and upper bounds was calculated to test whether the indirect effect was significant, as shown in Table 3.

The full model explained 19.2% of the variance in attitudes towards antibiotic consumption ($R^2 = 0.192$). Health engagement had a significant positive effect on orientation to health literacy ($\beta = 0.2964$, $P < .001$; H1 confirmed), which was positively associated with attitudes towards antibiotic consumption ($\beta = 0.4410$, $z = 14.936$, $P < .001$; H2 confirmed). The indirect effect of health engagement on attitudes, mediated by orientation to health literacy, was also significant ($\beta = 0.1307$, $P < .001$; H3 confirmed).

The direct effect of health engagement on attitudes towards antibiotic consumption was not significant ($\beta = -0.0103$, $P = 0.727$), indicating full mediation. However, the total effect of health engagement on attitudes remained significant ($\beta = 0.1204$, $P < .001$), underscoring the mediating role of orientation to health literacy (Fig. 2).

Discussion

Main finding of this study

This study highlights the psychological mechanisms underlying the relationship between health engagement and attitudes towards antibiotic consumption. Results support the first hypothesis, confirming a positive and significant relationship between health engagement and orientation to health literacy. This aligns with previous findings showing that individuals actively managing their health are more likely to seek, understand, and effectively apply health information.[16,37]

The second hypothesis was also supported: orientation to health literacy was positively associated with attitudes towards antibiotic consumption. Individuals with a higher orientation to health literacy better understand when antibiotics are necessary and are more aware of the risks associate with misuse. Their ability to critically assess and engage with health information directly contributes to informed decision-making and reduces the risk of inappropriate consumption.[38,39]

Mediation analysis revealed that orientation to health literacy fully mediates the relationship between health engagement and attitudes towards antibiotic consumption. This suggests that being engaged in one's health is not sufficient on its own to promote appropriate antibiotic use. Rather, it is their motivation to be informed and their ability to interpret and apply health information that drive informed attitudes about antibiotics. Limited public knowledge on antibiotic use and AMR, also in countries like Italy, may explain why engagement alone does not translate into appropriate attitudes.

What is already known on this topic

To date, no studies have specifically explored the psychological mechanisms linking health engagement, orientation to

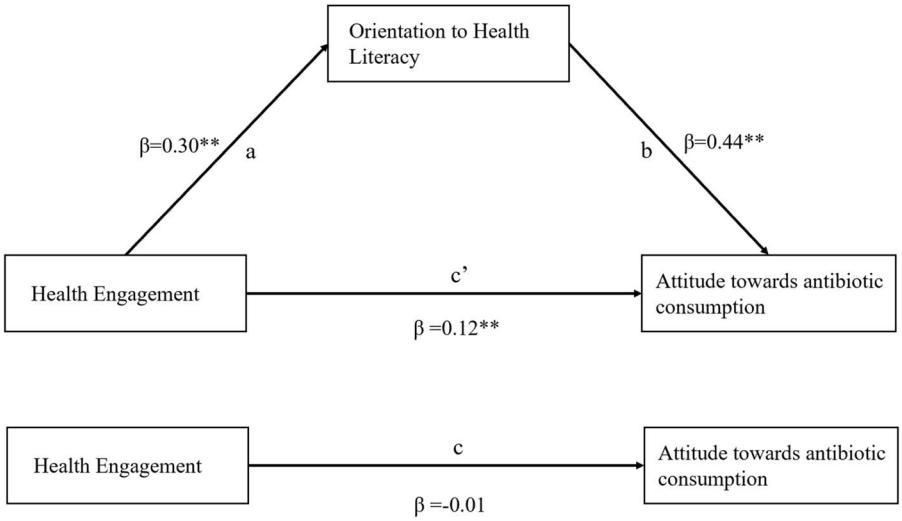

Figure 2 Results from mediation analysis (**$P < .001$; path a [H1]: relationship between health engagement and orientation to health literacy; path b [H2]: relationship between orientation to health literacy and attitude towards antibiotic consumption; path c' [H3]: relationship between health engagement and attitude to antibiotic consumption through orientation to health literacy; c: relationship between health engagement and attitude towards antibiotic consumption without the mediator orientation to health literacy.

health literacy, and attitudes towards antibiotic consumption in the context of AMR. While the behavioural and clinical dimensions of AMR have been widely studied, the role of psychosocial factors in shaping citizens' attitudes and decision-making around antibiotic use remains underexplored. Prior research has identified relevant psychosocial determinants of antibiotic-related behaviours. For instance, family norms, personality traits, and emotional distress (such as anxiety or somatization) have been shown to influence individuals' awareness of antibiotic risks and their intake behaviour.[40] Other relevant factors include attitudes (e.g. expecting antibiotics), patient–doctor interactions, knowledge about treatment indications, access to care, and characteristics of the prescribed treatment.[41] These findings underscore the importance of psychosocial dimensions in antibiotic use, but most have been examined without a unifying theoretical framework.

However, the literature has consistently highlighted the role of health engagement in promoting proactive health behaviours.[42] Individuals who are more engaged in managing their own health tend to be more receptive to health information and more inclined to adopt preventive practices. Similarly, numerous studies have shown that health literacy is associated with better health outcomes and more appropriate use of medications.

Finally, several studies have documented limited levels of public awareness regarding appropriate antibiotic use and the risks posed by AMR.[43–45] This gap in knowledge may contribute to the persistence of inappropriate antibiotic practices among the general population, even among those who are otherwise engaged in their health.

What this study adds

This result aligns with previous literature indicating that, although individuals who are more engaged in managing their health tend to exhibit higher levels of health-related behaviours and knowledge, engagement does not always translate into optimal decision-making regarding specific health domains such as antibiotic consumption.[46] A lack of specific knowledge and awareness on the appropriate consumption of antibiotics may prevent even motivated individuals from acting appropriately.

The significant total effect of health engagement on attitudes further supports combined role of these two dimensions in fostering responsible antibiotic use. Therefore, interventions aimed at improving antibiotic use practices should not only focus on increasing health engagement but also prioritize enhancing individuals' understanding of specific health information.

The findings also highlight the crucial mediating role of orientation to health literacy. Public health interventions should not only encourage individuals to actively engage in their health but also focus on enhancing their health literacy, including specific topics. Raising public awareness is therefore important to ensure that they can make informed, responsible decisions regarding antibiotic consumption. Targeted campaigns that provide clear, accessible information about when antibiotics are appropriate could help to fill the current knowledge gap. In particular, the implementation of training and educational activities addressing the target population can be an important factor in the success of such actions.[47,48] Similarly, the use of digital tools could increase knowledge.[49]

Citizen involvement in antibiotic stewardship programmes could be a way to increase awareness among citizens.[50] These programmes would engage individuals directly in the decision-making processes around antibiotic use, enhancing both their engagement and health literacy. Involving citizens in efforts to monitor and improve antibiotic practices may lead to more informed and responsible behaviours.

Although this study was conducted in Italy, the psychological mechanisms identified, particularly the mediating role of orientation to health literacy, may be relevant across contexts. However, generalizing the results requires caution, as several contextual factors may influence how these relationships manifest in other populations. National health policies, the accessibility of the healthcare system, the trust in health authorities, and population health literacy can all shape how these dynamics operate in different contexts.[51] In countries with high trust in medical authorities and effective public health communication strategies, citizens may be more receptive to educational interventions and more inclined to integrate accurate information into their decision-making processes. Conversely, in contexts characterized by misinformation, reduced access to healthcare, or health inequalities, these dynamics may be weaker or follow different pathways.[52–54] Cultural beliefs and social norms also play a significant role.[55] In some settings, antibiotics may still be perceived as a quick and reliable solution for a wide range of health issues, regardless of medical necessity. In others, cultural values such as deference to medical authority or health fatalism may reduce individual engagement or critical information-seeking.[56–59] These variations suggest that, while the structural model tested in this study offers a useful framework, its applicability may vary depending on the specific sociocultural and health system characteristics.

Finally, a One Health approach is fundamental to ensure the education not only of professionals but also of the general population, increasing awareness of the relationships between human, environmental, and animal health—with a relevant role reserved for combating AMR. Indeed, this phenomenon, being strongly amplified by human actions and behaviour, is particularly affected by people's literacy and knowledge. Increasing knowledge and literacy among professionals and the general population may be an effective tool to reduce the burden of AMR.[60]

Limitations of this study

This study presents some limitations. Despite the items showing good reliability, the constructs were measured using a non-validated scale, potentially introducing measurement inaccuracies or biases. This choice aimed to capture specific motivational and behavioural aspects not addressed by existing tools. Further research is needed to validate these measures and confirm their psychometric properties across diverse populations. Moreover, the study relied on self-reported data, which can introduce issues related to social desirability bias. Finally, the model accounts for 20% of the variance, suggesting that other factors not included in the model may have a significant impact on attitude towards antibiotic consumption. Further research should consider other psychosocial factors that may play a role, such as perceived risk and trust in healthcare professionals.

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

Conflict of interest. None declared.

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Data availability

The full dataset is available upon request to the first author.

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