

From Knowledge to Prevention: Intestinal Parasitic Infection Awareness and Preventive Practices among Future Teachers at the University of Benghazi, Libya

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من المعرفة إلى الوقاية: الوعي بالعدوى الطفيلية المعوية والممارسات الوقائية لدى معلمي المستقبل في جامعة بنغازي، ليبيا

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Abstract:

Background: Intestinal parasitic infections remain preventable yet persistent public-health problems shaped by water safety, sanitation, food handling, environmental exposure and health literacy. Students in faculties of education are a strategically important group because their future professional role can extend health knowledge from universities to schools, families and communities. This study assessed intestinal-parasite knowledge, disease awareness and preventive practices among female students at the Faculty of Education, University of Benghazi, and interpreted the findings through One Health and Sustainable Development Goal (SDG) frameworks.

Methods: A cross-sectional paper-based questionnaire survey was conducted among 300 female students at the Faculty of Education, University of Benghazi, between October 2024 and January 2025. Participation was voluntary, and questionnaires were distributed manually. Seven knowledge items and five awareness items were coded on five-point scales, and eight preventive-practice items on three-point scales. Data were analysed using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA). Internal consistency was assessed using Cronbach's alpha. Descriptive statistics, Spearman's rank correlations and Kruskal–Wallis tests with epsilon-squared effect sizes were used; false-discovery-rate correction was applied to multiple subgroup comparisons. The analytical dataset contained no participant names or direct personal identifiers.

Results: Internal consistency was high for knowledge ($\alpha=0.916$) and preventive practices ($\alpha=0.847$) and acceptable-to-good for awareness ($\alpha=0.804$). Mean knowledge was 3.45/5 (SD 1.06; 95% CI 3.33–3.57), awareness 3.20/5 (SD 1.00; 95% CI 3.08–3.31), and preventive practice 2.46/3 (SD 0.54; 95% CI 2.40–2.52). Knowledge correlated strongly with awareness (Spearman's $\rho=0.791$, $p<0.001$) and moderately-to-strongly with practice ($\rho=0.623$, $p<0.001$); awareness also correlated with practice ($\rho=0.615$, $p<0.001$). Knowledge was strongest for clean water, utensil hygiene and handwashing, whereas recognition of intestinal protozoa was weakest. Preventive behaviour was strongest for washing produce and hand hygiene but weaker for separation of utensils and safe storage of cooked food. Age and academic year showed the largest subgroup effects across all three domains. **Conclusion:** Future teachers demonstrated useful preventive habits but only moderate disease

awareness and uneven parasite-specific knowledge. Teacher-training curricula provide a practical platform for strengthening applied parasitology, food safety and WASH literacy. Integrating these themes through a One Health approach can support SDGs 3, 4 and 6 while positioning future teachers as health-literacy multipliers.

Keywords: Intestinal Parasitic Infections; Future Teachers; Health Literacy; Preventive Practices; One Health; WASH; Sustainable Development Goals; Libya

الملخص

الخلفية: ما تزال الإصابات بالطفيليات المعوية تمثل مشكلة صحة عامة مستمرة وممكنة الوقاية، تشكلها سلامة المياه، والإصحاح البيئي، وتداول الأغذية، والتعرض البيئي، والتثقيف الصحي. وتُعد طالبات كلية التربية فئة ذات أهمية إستراتيجية لأن دورهن المهني المستقبلي يمكن أن ينقل المعرفة الصحية من الجامعات إلى المدارس والأسر والمجتمعات المحلية. تناولت هذه الدراسة تقييم المعرفة بالطفيليات المعوية، والوعي بالمرض، والممارسات الوقائية بين طالبات كلية التربية بجامعة بنغازي، وتفسير النتائج من خلال إطار "الصحة الواحدة" وأهداف التنمية المستدامة (SDGs).

المنهجية: أجريت دراسة مسحية مقطعية باستخدام استبيان ورقي بين 300 طالبة في كلية التربية بجامعة بنغازي خلال الفترة من أكتوبر 2024 إلى يناير 2025. كانت المشاركة طوعية، ووزعت الاستبيانات يدوياً. صُنفت سبعة عناصر خاصة بالمعرفة وخمسة عناصر خاصة بالوعي وفق مقياس ليكرت الخماسي، وثمانية عناصر خاصة بالممارسات الوقائية وفق مقياس ثلاثي النقاط. أُجري تحليل البيانات باستخدام برنامج التحليل الإحصائي (IBM SPSS) الإصدار 28.0. أُقيم الاتساق الداخلي باستخدام معامل ألفا كرونباخ. كما أُستخدم الإحصاء الوصفي، ومعامل ارتباط سبيرمان للترتيب، واختبار كروسكال-واليس مع قياس حجم الأثر (إيسلون المربعة)، وتم تطبيق تصحيح معدل الاكتشاف الخاطئ عند إجراء المقارنات متعددة المجموعات الفرعية. خلّت قاعدة البيانات التحليلية من أسماء المشاركين أو أي معرّفات شخصية مباشرة.

النتائج: أظهر الاتساق الداخلي درجة عالية لمجالي المعرفة ($\alpha = 0.916$) والممارسات الوقائية ($\alpha = 0.847$)، ودرجة مقبولة إلى جيدة لمجال الوعي ($\alpha = 0.804$). بلغ متوسط المعرفة $5/3.45$ (بالانحراف المعياري 1.06 ؛ وفترة ثقة 95% تتراوح بين $3.33-3.57$)، والوعي $5/3.20$ (بالانحراف المعياري 1.00 ؛ وفترة ثقة 95% تتراوح بين $3.08-3.31$)، والممارسات الوقائية $3/2.46$ (بالانحراف المعياري 0.54 ؛ وفترة ثقة 95% تتراوح بين $2.40-2.52$) ارتبطت المعرفة ارتباطاً قوياً بالوعي بمعامل سبيرمان $p = 0.791$ ، عند مستوى دلالة $p > 0.001$ ، وارتباطاً متوسطاً إلى قوي بالممارسة $p = 0.623$ ، عند $p > 0.001$ ؛ كما ارتبط الوعي بالممارسة ($p = 0.615$)، عند $p > 0.001$ كانت المعرفة في أعلى مستوياتها فيما يتعلق بالمياه النظيفة، ونظافة أدوات الطهي، وغسل اليدين، بينما كان التعرف على الأوليات المعوية هو الأضعف. كانت السلوكيات الوقائية أشد ما تكون في غسل المنتجات الزراعية ونظافة اليدين، في حين كانت أضعف في فصل أواني الطهي والتخزين الآمن للأطعمة المطهورة. أظهر العمر والسنة الدراسية أكبر الأثر بين المجموعات الفرعية عبر المجالات الثلاثة.

الخلاصة: أظهرت معلمات المستقبل عادات وقائية مفيدة، ولكن بوعي متوسط بالمرض ومعرفة غير متكافئة بالطفيليات المعوية. توفر المناهج الدراسية لإعداد المعلمين منصة عملية لتعزيز الطفيليات التطبيقية، وسلامة الأغذية، والتثقيف بمجالات المياه والإصحاح والنظافة الشخصية. يمكن لدمج هذه الموضوعات من خلال نهج "الصحة الواحدة" أن يدعم أهداف التنمية المستدامة الثالث والرابع والسادس، مع ترسيخ دور معلمات المستقبل كمضاعفات لمستوى التثقيف الصحي.

الكلمات المفتاحية: الإصابات بالطفيليات المعوية؛ معلمات المستقبل؛ التثقيف الصحي؛ الممارسات الوقائية؛ الصحة الواحدة؛ المياه والإصحاح والنظافة الشخصية؛ أهداف التنمية المستدامة؛ ليبيا.

Introduction

Intestinal parasitic infections (IPIs) include protozoan and helminth infections transmitted through overlapping food-, water-, soil- and hygiene-related pathways. Their clinical consequences range from transient gastrointestinal symptoms to persistent diarrhoea, malabsorption, anaemia and nutritional impairment. Although the relative contribution of individual parasites varies by population and ecology, inadequate sanitation, unsafe water, contaminated food and poor hand hygiene remain recurrent determinants of transmission [1,2]

The prevention of IPIs is therefore not solely a clinical issue. It depends on the interaction of human behaviour with food systems, sanitation infrastructure, water quality and the wider environment. A global meta-analysis found substantial contamination of vegetables and fruits with intestinal protozoa, highlighting the importance of irrigation water, produce washing and hygienic food preparation [3]. Similar evidence among food handlers indicates that intestinal protozoa remain relevant at the interface between personal hygiene and food safety [4]. These interconnected pathways are compatible with a One Health perspective, which frames human, animal and ecosystem health as interdependent and calls for coordinated, multisectoral prevention [5].

Health literacy is a critical component of this prevention chain. University education does not automatically ensure detailed knowledge of parasitic diseases. Recent work among health-sciences students found important gaps in formal training and parasite-specific knowledge despite strong recognition of hand hygiene [6]. University-based

studies in other settings have similarly identified uneven understanding of intestinal-parasite risk factors and inconsistent preventive behaviour[7]. These findings are especially relevant to students outside health-professional programmes, whose curricula may contain little formal parasitology or public-health training.

Students in faculties of education occupy a distinctive position because they are future teachers. Their health knowledge may later influence classroom practice, school health promotion and family behaviour. WHO and UNESCO emphasise that education systems and schools are central platforms for health promotion, and that health literacy should be embedded in learning environments rather than treated as a separate clinical responsibility [8,9]. School-based evidence further shows that gaps in parasite-related knowledge and hygiene behaviours can coexist with ongoing infection risk [10], while an educational intervention in Bangladesh demonstrated that structured health education can improve helminth-related knowledge, hygiene behaviour and infection outcomes [11].

The Libyan context adds further relevance. Contemporary studies continue to document intestinal parasitic infections in different parts of the country, including Sebha and Benghazi-region populations, indicating an ongoing need for surveillance, sanitation and health education [12,13]. Importantly, the Recent Benghazi research has highlighted the relevance of water, sanitation, food safety and One Health-oriented prevention in intestinal parasitic infections [13]. University-based research has also identified gaps in parasite-related knowledge among students [14].

Against this background, the present study assessed knowledge, awareness and preventive practice among female future teachers at the University of Benghazi using participant-level questionnaire data. Beyond descriptive item means, the analysis examined scale reliability, relationships between knowledge, awareness and practice, and variation across sociodemographic and academic groups. The interpretation is anchored in One Health and in SDGs 3 (Good Health and Well-being), 4 (Quality Education) and 6 (Clean Water and Sanitation).

Study aims and objectives

1. To quantify knowledge of intestinal-parasite transmission and prevention among future teachers.
 2. To assess awareness of symptoms, health consequences and personal susceptibility.
 3. To evaluate self-reported preventive practices related to hand hygiene, food handling and safe water.
 4. To assess the internal consistency of the knowledge, awareness and practice domains and examine their inter-relationships.
 5. To evaluate whether domain scores vary by age, academic year, residence, family size or academic specialisation.
 6. To interpret the findings through One Health, school health-promotion and SDG frameworks.
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Material and methods

Study design, setting and participants

A cross-sectional questionnaire-based study was conducted among female students at the Faculty of Education, University of Benghazi, Libya. Data were collected over a four-month period from October 2024 to January 2025. The questionnaire was administered manually in paper-based form to eligible students within the faculty. Participation was voluntary, and students were free to decline participation. A total of 300 completed questionnaires were included in the analysis, representing four age categories, four academic years, three residential settings, four family-size categories and nine academic specialisations. All completed questionnaires returned during the study period and meeting the eligibility criteria were included in the analysis, yielding a final analytical sample of 300 students.

Recruitment and sampling

Participants were recruited through direct distribution of the paper-based questionnaire within the Faculty of Education. Participation was based on voluntary willingness to complete and return the questionnaire. No random selection procedure was applied; therefore, the study sample is best described as a non-probability convenience sample.

Questionnaire domains and scoring

The questionnaire captured demographic characteristics together with knowledge, awareness, preventive-practice and environmental-context items. The primary psychometric analysis focused on three internally coherent domains available in the raw dataset: knowledge (7 items, coded 1–5), awareness (5 items, coded 1–5) and preventive practices (8 items, coded 1–3). Higher values indicated stronger knowledge, awareness or reported preventive practice within the coding structure of each domain. Because the domains used different response

ranges, raw means were interpreted within their original scales and were not directly compared as if they were equivalent metrics.

Data quality and confidentiality

Range checks were performed before analysis. Three responses fell outside the prespecified coding ranges—one in the knowledge domain, one in the awareness domain and one in the preventive-practice domain—and were treated as missing rather than truncated or reassigned. Domain scores were calculated as the participant-level mean of available items when at least 80% of items in that domain were present; all 300 participants remained eligible for domain-level analysis. The analytical dataset contained no participant names or direct personal identifiers. Results are presented only in aggregate form.

Statistical analysis

Data were analysed using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarised using frequencies and percentages. Item and domain scores were summarised using means, standard deviations (SDs), medians and interquartile ranges (IQRs), with 95% confidence intervals (CIs) for domain means. Internal consistency was assessed using Cronbach's alpha. Because composite-score distributions departed from normality, associations between knowledge, awareness and preventive-practice scores were examined using Spearman's rank correlation. Differences across age, academic year, residence, family size and academic specialisation were assessed with Kruskal–Wallis tests; epsilon-squared (ϵ^2) was reported as an effect-size estimate. To reduce false-positive findings across the set of subgroup tests, Benjamini–Hochberg false-discovery-rate adjustment was applied. A two-sided adjusted $p < 0.05$ was considered statistically significant.

Results and discussion

3.1 Participant characteristics

The analysis included 300 female students. The largest age groups were 18–20 years (32.0%) and 21–23 years (30.0%). Fourth-year students constituted 35.3% of the sample and third-year students 28.7%. Most participants lived in urban areas (65.3%). Biology was the largest single specialisation (22.7%), followed by educational and psychological sciences (17.3%) and Arabic language (15.7%).

Table 1. Demographic characteristics of participants (N=300).

Variable	Category	N	%
Age (years)	<18	60	20.0
	18–20	96	32.0
	21–23	90	30.0
	>23	54	18.0
Academic year	First	55	18.3
	Second	53	17.7
	Third	86	28.7
	Fourth	106	35.3
Residence	Urban	196	65.3
	Semi-urban	61	20.3
	Rural	43	14.3
Family size	<4	32	10.7
	4–6	130	43.3
	7–9	100	33.3
	≥ 10	38	12.7
Specialisation	Biology	68	22.7
	Educational and psychological sciences	52	17.3
	Arabic language	47	15.7
	Mathematics	36	12.0
	English language	35	11.7
	Computer science	29	9.7
	Educational technology	11	3.7
	Physics	12	4.0
	Art education	10	3.3

Scale reliability and domain-level profile

The three primary domains showed satisfactory internal consistency. Cronbach's alpha was 0.916 for knowledge, 0.804 for awareness and 0.847 for preventive practices. Mean knowledge was 3.45/5, awareness 3.20/5 and preventive practice 2.46/3. The lower awareness mean in the raw-data re-analysis is important because it indicates

that general prevention knowledge did not uniformly extend to symptom recognition, perceived susceptibility or observation of disease in the surrounding community.

Table 2. Reliability and descriptive profile of the primary questionnaire domains.

Domain	Scale	Mean	SD	Median	IQR	Cronbach α
Knowledge	1–5	3.447	1.060	3.857	2.429–4.286	0.916
Awareness	1–5	3.195	0.995	3.400	2.200–4.000	0.804
Preventive practices	1–3	2.462	0.536	2.625	2.125–2.875	0.847

Item-level knowledge, awareness and preventive practices

Knowledge was strongest for the role of clean water and sanitation of food utensils (mean 3.69) and for regular handwashing before eating and after toilet use (3.65). The weakest knowledge item was the ability to identify intestinal protozoa associated with contaminated food or environments (3.13). Within the awareness domain, the importance of hygiene among food handlers received the highest mean score (3.51), while direct observation of intestinal parasitic infection in the surrounding community was lowest (2.87). Preventive behaviour was strongest for washing vegetables and fruit (2.63) and handwashing (2.61), whereas using separate utensils for raw meat and vegetables (2.31) and safe storage of cooked food (2.35) were weaker.

Table 3. Item-level descriptive statistics after range checking.

Domain	Item	Mean	SD
Knowledge	Transmission through contaminated food or water	3.25	1.40
	Adequate cooking reduces risk	3.48	1.26
	Handwashing before eating/after toilet use reduces risk	3.65	1.39
	Clean water and food-utensil sanitation support prevention	3.69	1.28
	Children and older adults may be more vulnerable	3.47	1.29
	Contaminated soil/groundwater can be sources	3.46	1.20
	Ability to identify intestinal protozoa linked to contaminated food/environment	3.13	1.28
Awareness	Awareness of common symptoms	2.97	1.21
	Recognition that untreated infection may cause important health problems	3.48	1.34
	Observation of intestinal parasitic infection in surrounding community	2.87	1.22
	Perceived susceptibility of university students	3.15	1.17
	Importance of hygiene among food handlers	3.51	1.66
Preventive practices	Regular handwashing before meals and after toilet use	2.61	0.66
	Washing/cleaning vegetables and fruits before consumption	2.63	0.69
	Using clean/safe drinking water	2.49	0.77
	Avoiding food from unreliable or unhygienic places	2.38	0.81
	Avoiding inadequately cooked or partially grilled meat	2.39	0.81
	Healthy storage of cooked food	2.35	0.83
	Using separate utensils for raw meat and vegetables	2.31	0.82
	Covering food to protect it from insects and dust	2.53	0.76

3.4 Relationships between knowledge, awareness and practice

Knowledge, awareness and preventive practice were positively related. The strongest relationship was between knowledge and awareness ($\rho=0.791$), followed by knowledge and practice ($\rho=0.623$) and awareness and practice

($p=0.615$); all correlations were statistically significant at $p<0.001$. The results indicate that stronger theoretical and risk-related understanding is associated with more protective self-reported behaviour, although the cross-sectional design does not establish direction of causality.

Table 4. Spearman correlations among the primary study domains.

Pair of domains	Spearman ρ	p value	Interpretation
Knowledge – awareness	0.791	<0.001	Strong positive association
Knowledge – preventive practice	0.623	<0.001	Moderate-to-strong positive association
Awareness – preventive practice	0.615	<0.001	Moderate-to-strong positive association

3.5 Sociodemographic and academic variation

After false-discovery-rate adjustment, age, academic year, family size and academic specialisation were significantly associated with all three domain scores. The largest effect sizes were observed for age ($\epsilon^2=0.314$ – 0.347), followed by academic year ($\epsilon^2=0.152$ – 0.179). Residence was not associated with knowledge or awareness, although a small association was observed with preventive practice (adjusted $p=0.014$; $\epsilon^2=0.023$).

Table 5. Group differences in domain scores with false-discovery-rate correction.

Grouping variable	Domain	Kruskal–Wallis H	FDR-adjusted p	ϵ^2
Age	Knowledge	105.57	<0.001	0.347
	Awareness	98.40	<0.001	0.322
	Practice	95.88	<0.001	0.314
Academic year	Knowledge	50.13	<0.001	0.159
	Awareness	55.89	<0.001	0.179
	Practice	47.95	<0.001	0.152
Residence	Knowledge	2.85	0.241	0.003
	Awareness	3.65	0.172	0.006
	Practice	8.82	0.014	0.023
Family size	Knowledge	23.89	<0.001	0.071
	Awareness	29.05	<0.001	0.088
	Practice	14.51	0.003	0.039
Specialisation	Knowledge	31.23	<0.001	0.080
	Awareness	36.09	<0.001	0.097
	Practice	42.11	<0.001	0.117

Discussion

The findings indicate that future teachers generally reported favourable routine preventive practices, whereas symptom awareness and parasite-specific knowledge were less consistent. The satisfactory internal consistency of the three domains supports the reliability of the composite scores within this sample.

The weakest knowledge item concerned recognition of intestinal protozoa. This finding is consistent with broader university-level evidence showing that students may recognise hygiene messages without possessing detailed parasitological understanding [6,7]. For future teachers, this distinction matters. Memorising general advice such as handwashing is useful, but effective health education also requires an understanding of faecal–oral transmission, contaminated water and produce, and the difference between protozoan and helminth pathways. A teacher who understands these mechanisms is better positioned to explain prevention accurately rather than simply repeat rules.

The practice pattern was similarly informative. Washing produce and hand hygiene were comparatively strong, whereas separation of utensils and safe storage of cooked food were weaker. This suggests that basic personal hygiene is more established than cross-contamination control and food-storage practice. Such gaps are epidemiologically relevant because foodborne parasite transmission is not restricted to direct ingestion of visibly contaminated material. Systematic review evidence shows that intestinal protozoa can contaminate vegetables and

fruits across production and handling chains [3], while food handlers can contribute to transmission when hygiene is inadequate [4].

The positive correlation between knowledge and practice ($p=0.623$) and between awareness and practice ($p=0.615$) is important. It argues against describing the data as a complete 'knowledge–practice gap'. Instead, the findings suggest partial translation: students with stronger knowledge and awareness tended to report better behaviour, but specific food-safety practices remained weaker. Educational interventions should therefore retain general hygiene messages while adding applied, skills-based content on produce washing, safe water, cross-contamination, food storage and recognition of common intestinal parasites.

Age and academic year showed the largest subgroup effects. Because these variables are closely related in university populations, their associations should not be interpreted as independent effects. Nevertheless, the observed variation supports consideration of earlier curricular integration of parasite-prevention and WASH concepts. Differences across specialisations also indicate that exposure to scientific content may be uneven across the Faculty of Education.

The Libyan evidence base provides a public-health rationale for strengthening this educational role. Ibrahim and Salem [12] documented continuing intestinal parasitic infections in Sebha. Recent research from Benghazi has also demonstrated the clinical and One Health relevance of paediatric *Entamoeba* infection, linking prevention with water, sanitation and food-safety systems [13]. University-based research has similarly identified gaps in parasite-related knowledge among students [14].

The study did not directly assess animal infection or environmental contamination; therefore, its One Health relevance relates primarily to the behavioural and environmental pathways addressed by the questionnaire. The survey did not measure infection in animals or environmental samples, so it cannot establish zoonotic or environmental transmission directly. The study did not directly assess animal infection or environmental contamination; therefore, its One Health relevance relates primarily to the behavioural and environmental pathways addressed by the questionnaire. These include safe water, food hygiene, soil and environmental contamination, animal-associated contact and waste management within interconnected human–animal–environment systems [5,15].

The educational implications also align with sustainable development. SDG 3 is relevant through prevention of communicable and neglected parasitic diseases; SDG 4 through the preparation of teachers capable of delivering accurate health education; and SDG 6 through safe water, sanitation and hygiene. WHO and UNESCO guidance on health-promoting schools supports embedding health and well-being within education systems rather than treating health education as an optional add-on [8,16,17,18]. For the Faculty of Education, a concise parasitology-and-WASH module could therefore have value beyond the university by equipping future teachers to transmit practical, evidence-based prevention messages to school communities.

One Health and SDG implications

From an applied perspective, these findings support incorporating safe water, food hygiene, environmental sanitation and parasite-prevention principles into teacher education. Collaboration between parasitology specialists, public-health educators and teacher-training staff could help translate these concepts into future school-based health promotion.

Strengths and limitations

A major strength is the use of participant-level data, which allowed range checks, reliability assessment, correlation analysis, effect-size estimation and multiplicity control. The study also addresses a rarely examined group—future teachers—whose potential influence on school health gives the findings practical relevance. Several limitations should be recognised. The design is cross-sectional and based on self-report, so causal inference is not possible and socially desirable responses may inflate preventive-practice estimates. The sample comprised female students from a single faculty and university, limiting generalisability, and the extent to which the sample represents all students in the Faculty of Education cannot be established from the present design. Several environmental-context items used heterogeneous response formats and were therefore not combined into a single psychometric scale.

Conclusion

Future teachers at the University of Benghazi demonstrated useful routine preventive practices but only moderate awareness and uneven parasite-specific knowledge. Knowledge, awareness and preventive practice were positively inter-related, with the strongest association observed between knowledge and awareness. The findings support early, structured integration of intestinal-parasite prevention, food safety and WASH literacy into teacher

preparation. Such an approach can position future teachers as health-literacy multipliers and connect university education with One Health and progress towards SDGs 3, 4 and 6.

Declarations

Participation was voluntary, and completion and return of the anonymous questionnaire indicated willingness to participate. No participant names or direct personal identifiers were collected, and data were analysed in aggregate form.

Conflict of interest: No conflict of interest is declared.

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