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Utilization of long lasting insecticidal net among children aged less than five years in a tertiary health facility in south-west Nigeria

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ABSTRACT

Introduction: Long-lasting insecticidal nets (LLINs) are the most widely used vector control interventions for preventing malaria transmission. The study sought to determine the regular use of LLIN, factors associated with the usage and the effect of regular LLIN utilization on the development of malaria among under-five children.

Methods: This was a hospital-based cross-sectional observation study. We enrolled consecutive caregivers with their children aged 6 to 59 months who presented with fever in the absence of a localizing sign. A structured questionnaire was used to obtain information about the level of utilization of LLIN. Malaria parasitemia was detected using the *P. falciparum* rapid diagnostic test kit and/or microscopic examination of blood.

Results: A total of 303 children/caregivers pair was studied. The mother's mean (SD) age was 37.17 (6.75) years, while the children was 24.36 (16.63) months. The majority (183; 60.4%) of the children were male. Parental awareness of LLIN was high (96.7%), LLIN ownership was 72.3%, however, only 119 (39.3%) were regular user of LLIN. Factors significantly associated with regular LLIN use were younger age, parental awareness, ownership of LLIN, source of acquisition of LLIN and permanently hanging the LLIN on sleeping space ($p = 0.031, 0.010, 0.000, 0.006$ and 0.000 respectively). Using binary logistic regression, the child's age, source of LLIN and hanging the LLIN permanently on the bed remained statistically significant to the regular use of LLIN ($p = 0.046, 0.035$ and 0.000 respectively).

The frequency of malaria was significantly higher among the children who did not use and those who uses LLIN irregularly (97.1% versus 32.9%, $p = 0.000$).

Conclusions: Regular use of LLIN is low in the study area. Hanging the insecticidal bed-net permanently on the bed/sleeping space promotes its regular usage. The frequency of malaria was reduced among the children using the LLIN regularly.

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Long-lasting insecticidal nets; utilization; associated factors; malaria parasitemia



1. Introduction

Malaria is an infectious disease caused by the plasmodium species. It is a significant cause of morbidity and mortality and has consistently been a major public health problem in developing countries [1]. The world malaria report 2020 estimates about 229 million cases of malaria globally in 2019 [2]. The African region still bears about 94% of the global malaria burden [2]. Nigeria has the highest estimated number of about 27% of the global malaria cases and 23% of global malaria deaths [2,3]. In 2019, about 67% (274 000) of all malaria death occurs in children aged under five years worldwide [4]. Children particularly those under five years of age are at higher risk of contracting and developing the severe form of malaria [2–4].

The World Health Organization (WHO) recommends the use of long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) as vector control interventions for reducing malaria transmission in the at-risk population [2,4]. LLIN offers physical protection

from a mosquito bite and the pyrethroid treatment causes paralysis and death of the mosquito [2,4]. The use of LLIN has contributed significantly to the decline in malaria episodes by almost a half [5,6]. In malaria-endemic areas, LLINs have effectively reduced severe disease and malaria-related mortality by 45% and 55% respectively in children less than five years of age [7].

To achieve a reduction of the malaria burden to the pre-elimination level, the national malaria strategic plan aims to ensure at least 80% of the targeted population utilizes appropriate preventive measures by the year 2020 [8]. Factors such as knowledge about LLIN, socio-cultural, environmental factors and seasonality of malaria influence the use of LLINs [9,10]. Despite many advocacies and evidence-based benefits of LLIN, its utilization among households remains far from universal coverage [4]. Some Nigerian studies have reported a low LLIN utilization rate of 18.5%, 26.1% and 52.4% respectively among children under the age of five [10–12].

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Household ownership of LLIN in the southwest region is 44%, this estimate is still far from the national target of 80% by the year 2020 [3]. For LLIN to be constantly and effectively utilized, determination of the factors affecting its utilization is important. Malaria still remains a major reason why children present to the health facility. The southwest region has been reported to have a high prevalence of malaria and low ownership of LLIN [3]. The objective of this study was to determine the level of utilization of LLIN, factors affecting the regular use of LLIN and the prevalence of malaria among under-five children attending the Bowen University Teaching Hospital (BUTH), Ogbomoso, Southwest, Nigeria. This will help to identify any underperformance in the malaria control programme and to provide possible interventions where necessary.

2. Methods and materials

2.1. Study area

The study was conducted at the Children out-patient clinic and the Children emergency unit of BUTH, Ogbomoso, Nigeria from April to June 2021. The hospital serves as a referral center to primary and secondary health care facilities in and around Ogbomoso, including neighboring states.

2.2. Ethics

Ethical approval was obtained from the BUTH Research Ethics Committee (HREC), with protocol number BUTH/REC-095. Before enrollment, written informed consent was obtained from the caregivers. Patients' information was kept confidential. All ethical principles were observed following the ethical standards of the Helsinki Declaration of 1975, as revised in the year 2000.

3. Study design

This was a hospital-based cross-sectional observational study. Child-parent/caregiver pairs were recruited. Eligible children were those between the ages of 6 to 59 months who presented with fever without a localizing sign and whose parents or caregivers gave consent. Children who received blood transfusion a month before the study were excluded in order to leave out cases of transfusion malaria. The child's history of illness, use of anti-malaria drugs, and use of insecticidal nets were obtained from the parent/ caregiver using a direct questionnaire method. For this study, the level of LLIN use was categorized as "regular use" based on parents' or caregivers' self-report of LLINs utilization on daily basis (every day) in the preceding seven days

before the survey [13]. "Non-/irregular users" are those who do not sleep under LLIN or those who do not sleep under LLIN on a daily basis consistently.

4. Sample size determination

The sample size for the study was obtained using the formula [14]:

$$nf = n/1 + (n/N)$$

$$n = \frac{Z^2pq}{d^2}$$

The minimum sample size was 265; however, 303 subjects were recruited into the study, at a 95% confidence level using a proportion of children using an insecticide-treated net of 41.7%, derived from a previous study [3].

The participants were recruited consecutively until the sample size was complete.

4.1. Data collection methods

Data were collected using a structured questionnaire that was developed from previously published literature; this was administered directly to the respondents. The questions include the demographic characteristics, family size, parental educational level and occupation, LLIN ownership, and regular use of LLINs among children aged less than five years in the household. The socio-economic classification of the children was based on the rank assessment of parental occupation and the level of education as recommended by Ogunlesi *et al* [15]. The average score for both parents were used to assign their children to socio-economic classes I to V; which were further classified as upper (classes I and II), middle (class III), and lower (classes IV and V). Clinical examination was performed on all the participants. Blood specimen was collected for malaria testing using the SD BIOLINE malaria Antigen histidine-rich protein 2 (HRP-2) *P. falciparum* test kit. The test was read 30 minutes later, it was adjudged positive if there were two color bands (test and control line) and negative if only one color band (control line) was present. Microscopic examination of blood film for malaria parasites was done in the laboratory following standard procedures [2]. This was done for patients with a strong suspicion of malaria but whose rapid diagnostic tests (RDT) were negative.

4.2. Operational definition

Malaria: an acute febrile illness caused by plasmodium parasite confirmed using parasite-based diagnostic testing (through either microscopy or a rapid diagnostic test) [4,16].

LLIN: a factory treated mosquito net with insecticide incorporated within the fibers.

Ownership of LLIN: was defined as having at least one LLIN in the household at the time of the interview [9].

Regular LLIN Utilization: a child (index child) who was reported to have slept under LLIN every day in the preceding seven days before the interview.

Outcome variables were regular use of LLIN. This was measured using the question “how often did your child sleep under a treated bed-net in the last seven days (last week)?” The response categories were never, irregular (the child used LLIN at least once during the week but less than every day) and regular (i.e. every-day use).

4.3. Pretesting of questionnaire

Questionnaires were pretested at the Pediatric surgical outpatient clinic; these questionnaires were not included in the data analyses.

4.4. Data analyses

Data analyses were done using Statistical Package for Social Sciences (SPSS) TM version 23.0 for windows. Categorical data were presented as frequency and percentages, while continuous variables were presented as mean and standard deviation (SD). The Pearson’s Chi-square test was used to determine the association between socio-demographic characteristics, utilization of LLIN and presence of malaria, while the independent t-test was used to compare means. Statistical significance was established when the p-value is less than 0.05.

5. Results

5.1. Socio-demographic characteristics of the participants’ parents

A total of 303 parents/caregivers were studied. The father’s and mother’s mean (SD) ages were 37.17 (6.75) and 31.19 (6.20) years respectively. Most (47.9%) of the fathers were in the class 3 category of occupation while the mothers (53.1%) were in class 4. One hundred and twenty-four (40.9%) of the mothers had only secondary school education and this formed the majority. (Table 1)

5.2. Socio-demographic characteristics of the children and malaria diagnosis

Three hundred and three children were studied. The majority, 183 (60.4%) of the participants were male. The age range of participants was 6 months to 5 years,

with a mean (SD) of 24.36 (16.63) months. More than one-third (33.7%) of the subjects were infants (between 6 and 12 months). One hundred and fourteen (37.6%) of the children were from the middle socio-economic class. Two hundred and thirteen (70.3%) participants had evidence of malaria. (Table 2)

5.3. Knowledge, ownership and utilization of LLIN among the participants

The level of awareness/ knowledge of LLIN was high as this was observed in 297 (96.7%) of the caregivers, while 219 (72.3%) caregivers own at least a LLIN. Among those who own a LLIN, 53.9% of them collected the LLIN during their visit to a health facility and 176 (80.4%) had the net permanently hung over their bed/ sleeping space. One hundred and nineteen (39.3%) children used the LLIN regularly (daily) in the preceding seven days. (Table 3)

5.4. Relationship between LLIN use and participants’ characteristics

There was a significant association between the mean age ($p = 0.031$), parental knowledge of LLIN ($p = 0.010$), ownership of LLIN ($p = 0.000$), source of LLIN ($p = 0.006$), permanent hanging of net on sleeping space ($p = 0.000$) and the regular use of LLIN. (Tables 4 and 5)

5.5. Binary Logistic regression of factors associated with regular use of LLIN

Regression models were used to evaluate the association between the significant variables and regular LLIN use. The child’s age, source of LLIN and hanging the LLIN permanently on the bed remain statistically significant to the regular use of LLIN ($p = 0.046$, 0.035 and 0.000 respectively). A younger child whose caregiver purchased the LLIN with the LLIN permanently hung on bed was more likely to use the LLIN. (Table 6)

5.6. Malaria diagnosis among categories of LLIN users

A higher proportion of children who were non/ irregular users of LLIN developed malaria as compared to those using it regularly (67.1% versus 32.9%). There was a statistically significant association between LLIN utilization and the development of malaria. $X^2 = 12.355$, $p = 0.000$. (Figure 1)

6. Discussion

Access to and proper use of LLIN is vital in the effective control of malaria. The findings of this study indicate that the level of caregiver awareness of LLIN was very

Table 1. Socio-demographic characteristics of the participants' parents.

Socio-demographic profile	Frequency (n) n = 303	Percentage (%)
Fathers' mean age (in years)	37.17 ± 6.75	
Mothers' mean age (in years)	31.19 ± 6.20	
Father's occupation	2	0.7
Class 1	31	10.2
Class 2	145	47.9
Class 3	119	39.3
Class 4	6	2.0
Class 5		
Mother's occupation	3	1.0
Class 1	9	3.0
Class 2	112	37.0
Class 3	161	53.1
Class 4	18	5.9
Class 5		
Paternal education	6	2.0
PhD, Masters	104	34.3
Bachelor, HND	55	18.2
OND, NCE, Technical	106	35.0
SSCE, JSCE	32	10.6
Primary, No formal education		
Maternal education	2	0.7
PhD, Masters	84	27.7
Bachelor, HND	56	18.5
OND, NCE, Technical	124	40.9
SSCE, JSCE	37	12.2
Primary, No formal education		

PhD- Doctor of Philosophy, **HND**- Higher National Diploma, **OND**- Ordinary National Diploma, **NCE**- Nigerian Certificate in Education, **SSCE**-Senior Secondary Certificate Examination, **JSCE**- Junior Secondary School.

Class 1- Professionals, high-Scale trading, **class 2**- Senior Government employee, **class 3**- Junior Government employee, middle-Scale Trading Clergy, Teachers, Technicians, Retirees **class 4**- Petty traders, unskilled workers and security agents, **class 5**- Laborers, messengers, apprentices, students, and unemployed

Table 2. Socio-demographic characteristics of the participants and malaria diagnosis.

Socio-demographic profile	Frequency (n) n = 303	Percentage (%)
Age (in years)	102	33.7
6-12	87	28.7
13 - 24	51	16.8
25-36	30	9.9
37 - 48	33	10.9
49-60		
Gender	183	60.4
Male	120	39.6
Female		
Socio-economic status	92	30.4
Upper	114	37.6
Middle	97	32.0
Lower		
Family size	149	49.2
<5 members	154	50.8
≥5 members		
Malaria diagnosis	213	70.3

high (96.7%). However, although 96.7% of the caregivers had knowledge of LLIN, only 72.3% of the participants own at least one LLIN. This finding is similar to the net ownership of 69.0% reported among children less than five years in Malawi [17] and 71.0% in western Kenya [18]. In previous Nigerian studies, an ownership rate of 68.6% and 72.0% has been reported [19,20], this is comparable with our finding. The LLIN ownership rate in this study is however higher than that reported by Oresanya *et al* [9].

Although the LLIN ownership rate in this study is still below the national target of 80% by the year 2020, there is a significant improvement as compared to the

Table 3. Knowledge, ownership and regular utilization of LLIN among the participants.

Socio-demographic profile	Frequency (n) n = 303	Percentage (%)
Parental knowledge of LLIN	293	96.7
Ownership of LLIN	219	72.3
Regular LLIN use	119	39.3
Source of LLIN (n = 219)	25	11.4
Purchase	118	53.9
Free collection	76	34.7
Health facility		
Health campaign		
LLIN permanently hung on bed (n = 219)	176	80.4

LLIN ownership of 44% recorded in the southwest region as presented by the Nigeria Demographic and health survey in 2018 [3]. This study showed that household ownership of LLIN has increased; this could be an indicator of the effectiveness of the LLIN distribution channel within the community. The majority of the caregivers in this present study received free LLINs during their visit to a health facility. Similar to our finding, earlier studies reported that the presence of formal health facilities in the community predicted a high level of LLIN possession [9,20].

This study finding highlights that there is a wide gap between LLIN ownership and the regular use of LLIN. This is consistent with previous studies that observed that LLIN ownership does not translate into net utilization [11,17,21]. Our study showed that only 39.3% of the children used it regularly. This rate is comparable to 37.2% reported by Admasie *et al* [22]

Table 4. Relationship between LLIN use and participants' characteristics.

Variables	LLIN use (n = 303)		Test statistics	P-value
	Regular n(%)	No/ Irregular n(%)		
Fathers' mean age (years)	37.34 ± 6.79	37.07 ± 6.73	t = -0.352	0.725
Mothers' mean age (years)	31.19 ± 6.02	31.20 ± 6.32	t = 0.003	0.997
Paternal education	1 (16.7)	5 (83.3)	χ ² = 3.649	0.456
PhD, Masters	44 (42.3)	60 (57.7)		
Bachelor, HND	24 (43.6)	31 (56.4)		
OND, NCE, Technical	36 (34.0)	70 (66.0)		
SSCE, JSCE	14 (43.8)	18 (56.3)		
Primary, No formal education				
Maternal education	1 (50.0)	1 (50.0)	χ ² = 2.184	0.702
PhD, Masters	32 (38.1)	52 (61.9)		
Bachelor, HND	22 (39.3)	34 (60.7)		
OND, NCE, Technical	53 (42.7)	71 (57.3)		
SSCE, JSCE	11 (29.7)	26 (70.3)		
Primary, No formal education				
Children's mean age (months)	21.81 ± 15.38	26.02 ± 17.23	t = 2.165	0.031
Children's gender	80 (43.7)	103 (56.3)	χ ² = 3.833	0.051
Male	39 (32.5)	81 (67.5)		
Female				
Social class	36 (37.1)	61 (62.9)	χ ² = 0.587	0.746
Low	44 (38.6)	70 (61.4)		
Middle	39 (42.4)	53 (57.6)		
Upper				
Family size	59 (39.6)	90 (60.4)	χ ² = 0.013	0.910
<5	60 (39.0)	94 (61.0)		
≥5				

Table 5. Relationship between LLIN use and parental knowledge and ownership of LLIN.

Variables	LLIN use (n = 303)		Test statistics	P-value
	Regular n(%)	No/irregular n(%)		
Parental knowledge of LLIN	119 (40.6)	174 (59.4)	χ ² = 6.688	0.010
Yes	0 (0.0)	10 (100.0)		
No				
Ownership of LLIN	119 (54.3)	100 (45.7)	χ ² = 75.163	0.000
Yes	0 (0.0)	84 (100.0)		
No				
LLIN source (n = 219)	20 (80.0)	5 (20.0)	χ ² = 7.490	0.006
Purchased	99 (51.0)	95 (49.0)		
Free				
LLIN permanently hung (n = 219)	116 (65.9)	60 (34.1)	χ ² = 48.371	0.000
Yes	3 (7.0)	40 (93.0)		
No				

Table 6. Binary logistic regression of factors associated with regular use of LLIN.

/	Outcome = regular LLIN use		
	Odds ratio	95% CI	p-value
Child's age	0.983	0.967–1.000	0.046
Parental knowledge of LLIN	0.000	0.000	0.999
Ownership of LLIN	0.000	0.000	0.996
LLIN source	0.293	0.093–0.919	0.035
LLIN permanently hung on bed	0.040	0.012–0.136	0.000

CI- Confidence interval

among under-five year old children in Ethiopia. Our rate is lower than 63.0%, 65.0% reported among children under the age of 5 years in Ethiopia and Kenya [22,23] and 61.8% recorded in Lagos, Nigeria [21]. The low level of LLIN utilization observed in this study may be attributed to the difference in the criteria used in defining LLIN utilization. The current study defined "regular utilization" as the use of LLIN on daily basis (every day) in the preceding seven days before the survey, whereas the other studies considered

"utilization" as sleeping under LLIN in the preceding night before the survey. Utilization of LLIN a night before the interview may be limited in assessing compliance with the use of LLIN and may not be highly decisive for those who will develop malaria parasitemia.

In a Nigerian study by Ovadje *et al* [13], a utilization rate of 18.0% was observed among the children using LLIN every day in the week before the survey [13]. The higher rate observed in our study may

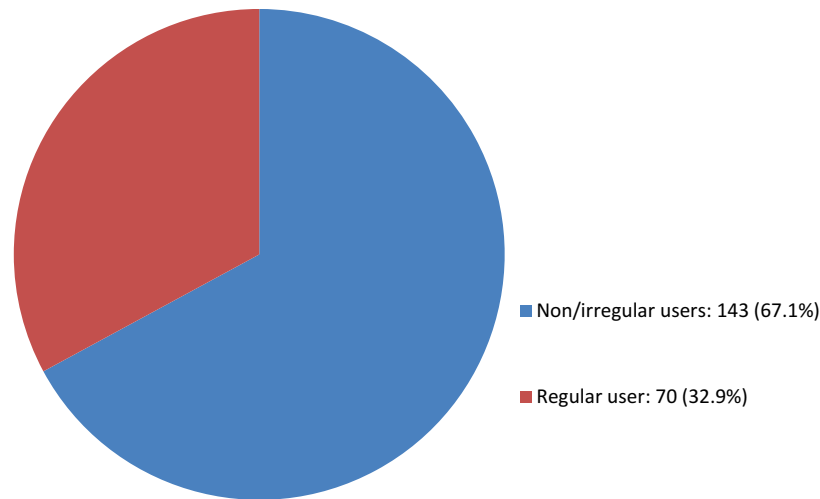


Figure 1. Malaria diagnosis among categories of LLIN users.

be due to the difference in the age categories of the children studied. The present study involved children less than 60 months while Ovadje *et al* studied children up to 14 years. An earlier study has shown that children less than five years old tend to use LLIN more frequently than older children, especially in the setting of households not having enough nets for all children in the family [24]. There is a scarcity of studies that have examined regular (daily) use of insecticidal bed nets; this has limited the opportunity for further comparability of findings.

For those who were not using the LLIN regularly, the main reason given was that the bed net causes excessive heat. The use of indoor insecticidal spraying and the presence of window and/or door nets discouraged its usage in some households as some of the caregivers assumed it was equally effective as LLIN. Some caregivers presumed there was no mosquito in their house, while some complained of having to set it up daily. Another factor was the seasonal variation in the transmission of malaria; as some caregivers believed malaria transmission is more during the rainy season. This is not reassuring as irregular use of the LLIN may increase the vulnerability to malaria among under-five children.

This study highlights the factors significantly associated with regular use of LLIN as younger age, parental knowledge of LLIN, ownership of LLIN, source of LLIN and permanently hanging LLIN on sleeping space. Similar to previous studies [9,25] we observed that children of younger age (<24 months) were more likely to be put under LLIN than older children (>24 months). This may mean that parents preferentially use LLIN for younger children as some mothers sleep with their younger children under the net until they are weaned. In addition, Infants are frequently in contact with health workers, particularly during immunization visits to health facilities, their caregivers

are often reminded of the benefits of LLIN utilization and this has also encouraged its usage in this age group.

Parental knowledge of LLIN and ownership of LLIN were quite high among our participants. Studies have shown that parents who are aware of the benefits of LLIN are likely to use it more frequently compared with those without knowledge of LLIN benefits [12]. The source of LLIN has a significant association with the regular use of the bed net. Although the majority of the participants received the LLIN freely, it was observed that a very high percentage (80%) of those who purchased it used it regularly. This finding may be attributed to the financial implication of buying the net; as an item that is purchased is one that is desired or needed. In addition, willingness to buy LLIN implies that the benefits of owning and using a net are recognized, which is not necessarily the case if the LLIN has been given. Baume *et al* [26], observed that a personal decision to purchase a net may motivate one to use the LLINs rather than the one acquired free of charge.

Hanging the bed net permanently on the sleeping space significantly influenced the use of LLIN in the participants. This is consistent with the report by Kilani *et al* [27] who noted that hanging of net over a sleeping space is a strong predictor of use. Hanging the LLIN permanently on the sleeping space may serve as a constant reminder for the bed occupant(s) of the need for its use. In addition, permanent net hanging will prevent the associated lack of motivation and technical problems in the process of setting up and removing the bed net every day as this affects the consistency in the daily utilization of bed nets.

There was no statistically significant association between social class and regular use of LLIN. This finding is in agreement with earlier reports who observed that socioeconomic class does not influence

the use of LLIN [11,21]. Some studies however have reported a higher utilization of LLIN among high-income households [9,24].

Our study shows that a significant proportion of those who use the LLIN regularly did not have malaria parasitemia. This is in agreement with previous studies which show that LLIN reduces clinical episodes and malaria parasitemia [6,12,28]. Although some children who were regular users of LLIN had malaria, this may mean that they might have been bitten by mosquitoes before using the bed-net at night as these children do not use LLIN throughout the day. Overall, this study reinforces the regular use of LLIN as an effective means of reducing malaria episodes.

6.1. Strength and limitation

The strength of this study is that utilization of LLIN was based on daily use in the preceding week and not limited to the use of LLIN a night before the interview. Also, fever was not used as a surrogate for symptomatic malaria. The diagnosis of malaria was based on the detection of malaria parasitemia using a rapid diagnostic test or microscopy examination of blood film.

As a limitation, the study did not visit the participants' households to confirm the usage of the LLINs, information was obtained from the caregivers through recall. Effort was however made to ensure proper understanding of the questionnaire to reduce recall bias.

7. Conclusion

The regular utilization of LLIN is low in the study area despite a high level of awareness and ownership of LLIN; with regular utilization being more likely in the younger child and hanging the insecticidal bed-net permanently on the bed/sleeping space. Regular use of LLIN remains important in the prevention of malaria in children aged less than five years.

8. Recommendation

There should be continual health education on the benefits of regular use of LLIN and a need for positive behavioral change toward the use of LLIN as a malaria control intervention. Caregivers should be encouraged to keep their bed net permanently hung over their sleeping space as its presence will serve as a constant reminder for its use. This will play a role in closing the gap between LLIN ownership and its utilization.

While making nets available through mass distribution, households with no/limited number of LLIN should be encouraged to buy LLIN (which should be made available at a very subsidized and affordable rate) to complement the effort of the government in the campaign for universal coverage' of LLIN.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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