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Factors Influencing Possession and use of Insecticide-Treated Nets: Introducing a New Aspect Among Economic Determinants

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Abbreviations: DRC: Democratic Republic of Congo; ITN: Insecticide Treated Net; LLIN: Long Lasting Insecticide-treated Net; NMCP: National Malaria Control Program; UNIKIN: University of Kinshasa; WHO: World Health Organization

ABSTRACT

Background: The coverage and use rates of insecticide-treated nets (ITNs) are still below the universal coverage targets in malaria-affected countries. Many factors are held responsible of these low rates and numerous studies have been conducted to bring them out. Unfortunately, less attention has been given to purely economic aspects of ITNs acquisition and use. There is lieu to recall that, besides mass distribution campaigns, ITN is a normal product in the marketplace, obeying to the law of supply and demand. As such, any factors influencing the supply and the demand of ITNs are likely to influence their use and deserve further attention. We conduct this study as a pilot one to introduce this new aspect in improving ITNs coverage and use.

Methods: A sample of 366 respondents was randomly selected among students from the University of Kinshasa student residences to conduct a descriptive cross-sectional study through a multi-stage sampling process. A questionnaire was planned and directly addressed to surveyed students. Perception of respondents on ITNs demand, supply, and market type was recorded and results were presented in frequencies and percentages.

Results: With a response rate of 100%, we found that ITNs coverage and use rates were 37.2% and 29.0% respectively. ITNs demand is likely to increase if consumers' preferences were increased, as for 66.7% of respondents. ITNs supply, in contrast, will increase if the price were raised up (57.9%), production procedures were improved (69.9%), and special influences come into existence (66.9%), describing ITNs manufacturers as pure profits seekers and decreasing consumers' willingness to purchase the product. On the other hand, ITNs market is considered imperfect competitive, characterized by such unattractive features as products inhomogeneity (61.7%), access restriction (53.8%), law of supply and demand inapplicability (72.1%), and lack of transparence (94.5%), decreasing the purchasing willingness of ITNs.

Conclusion: Resorting to the commercial sector is necessary in achieving universal coverage and use of ITNs. Public health professionals should take into account these new aspects of ITNs use determinants while developing malaria control interventions. They can enhance ITNs attractiveness to increase the demand, sensitize populations about their perception on ITNs supply, and improve ITNs market conditions so as to increase the acquisition and use of this precious material between mass distribution campaigns and control malaria effectively.

Introduction

Background

The Democratic Republic of Congo (DRC) is listed among both least developed and most malaria-affected countries [1]. Unsurprisingly, the rates of insecticide-treated bed nets (ITNs) coverage and use within the country are lower, compared to the World Health Organization (WHO) targets of 100% coverage and use for people at risk of malaria [2]. The National Malaria Control Program (NMCP) of the country reported, by 2018, 70% coverage and 55% utilization rates of the ITN [3]. Many studies have been conducted in relation with different determinants of the use of ITNs (Moon, et al. [4-6]). So far, unfortunately, less attention has been given to purely economic aspect of those determinants. The commonly reported economic determinant is the household income level. Nonetheless, as a product obeying to the law of supply and demand in the marketplace, the use of ITN cannot be explained by the sole household income level. We found it appropriate to deepen purely economic factors likely to determine the use of the ITN among populations.

Despite its mass distribution campaigns, whose costs are assumed by health partners and which anyways are periodical – a three-year interval between distributions per the WHO recommendations [7], the ITN is, as anything else and without astonishment any, a good offered at some price within the marketplace. This entails the problem of affordability for buyers, end-users, whose perception of the price can determine their attitude toward buying or not the ITN out of mass campaigns and continuous distributions (Adeneye, et al. [8]). In fact, as aforementioned, the malaria endemic affects mostly resources-limited countries. Hence, the price of ITN represents an important aspect for these populations in their attitudes to spending their low revenues in the ITN acquisition and thus its utilization, because mass distribution campaigns only are not sufficient to reach the WHO targets of universal coverage (Adeneye, et al. [7,8]). This is a serious issue since the utilization of the ITN in order to prevent and fight the malaria is ultimately headed by its acquisition or possession. In other words, there is no utilization without acquisition.

Economically speaking, numerous are factors that can influence the possession and utilization of a good, ITN in this specific case, according to the law of supply and demand. They can be categorized into three factors: supply, demand, and type of market (Azadeh, et al. [9,10]). The Figure 1 represents a conceptual framework illustrating these factors action on the use of ITN. The demand of ITNs is determinant in its utilization. An increase of demand is likely to increase its utilization accordingly. Conversely, a decrease in demand is likely to decrease its utilization as well. This demand is influenced by various factors such as, but not limited to, the price of ITNs, available income, price of substitute products, consumers' taste and preferences, and special influences, [11,12]. The demand is likely to increase when the price of ITNs decreases. The increase of consumers' income is likely to increase their capability to afford the price of ITNs and therefore increase its acquisition. When the price of such substitute products as indoor residual spraying (IRS) increases, the demand of ITNs is likely to increase proportionally. An increase in consumers' preference vis-à-vis the color or the shape of ITNs is likely to increase its demand.

Finally, the existence of special influences such as rain season – when it has been noticed an increase of mosquitos – is likely to increase the demand of ITNs. A move in opposite direction, different from ones described above, entails a decrease in ITNs demand and thus, a decrease in its utilization. The supply of ITNs by manufacturers plays a determinant role in its acquisition and use. When the supply decreases, the use of ITNs decreases accordingly. Many factors are likely to influence either positively or negatively the supply of ITNs [13]. When its price increases, the supply of ITNs increases as well, since manufacturers seek to maximizing profits. The production of ITNs in easy conditions, facilitated by new technologies with a reduction of production costs and manufacturing time, is likely to increase its supply. The supply of ITNs is likely to increase when the price of such substitute products as IRS decreases. Special influences such as rain season are likely to increase the supply of ITNs. In opposite cases, the supply of ITNs is likely to decrease, which entails a decrease in its utilization as well. The way buyers perceive manufacturers' motivations determine their willingness to buy their products or not (Lazaroiu, et al. [14,15]). When consumers perceive manufactures as egocentrics, trying to maximize profits on their expense, they become hesitant to acquire their products, which therefore decreases the use of ITNs. In this way, the supply and the demand of ITNs are strongly interlinked, as stressed by the famous law of supply and demand.

There are two types of market: perfectly competitive market and imperfect competitive market. A market is said perfectly competitive when it can meet the criteria of atomicity, products homogeneity, access freedom, law of supply and demand application, and transparency (Pettinger [16]). When one of these criteria is missing, the market is said imperfect competitive. In fact, a perfectly competitive market is referred to as a market in which there is a perfect balance between sellers, buyers, and buyers and sellers (Hayes, et al. [16,17]). Such a market is the one proper to attract people to acquire the ITN and thus increases its use. The imperfect competitive market, on the contrary, is perceived as an unfair market where a group of individuals is taking profit on the expense of others (Depersio, et al. [18,19]). Such a market is unlikely to attract people to buy the ITN and thus decreases its

use. Considering what precedes, the study, as a new perspective in ITN-related researches, aimed at analyzing whether the perception of respondents on ITNs supply, demand, and market type is likely to influence ITNs possession and use by addressing the following research questions:

- What are ITNs coverage and use rates within student residences?
- What is the perception of students on ITNs demand?
- What is the perception of students on ITNs supply?
- How do they consider the ITNs market?

Methods

Study Area and Participants

The main objective pursued was to analyze students' perception on ITNs supply, demand, and type of market. To that end, a descriptive cross-sectional study was carried out. The study population was made of the University of Kinshasa (UNIKIN) students living in student residences. The UNIKIN comprises seven student residences divided into two categories, female residences and male residences. Three female residences are numbered, which are namely Home Vatican, Home 80, and Home 150. On the other hand, the four male residences comprise namely Home Plateau, Home X, Home XX, and Home XXX. Every residence is built in blocs of either two or three corridors each, with an overall number of 61 corridors. To be included in the study, a student should be registered in the University of Kinshasa, should be living in student residences, and should have spent the night preceding the survey in their room. Were excluded from the study, any students who met the inclusion criteria but retracted from responding to the survey, according to the informed consent policy. The choice of students as the study population was motivated by the low budget of the study, the promptness in data collection, the non-response rate minimization, and their prompt understanding of the questionnaire.

Study Design

The number of students who constituted the study sample was computed thanks to the sampling process formula. The study has considered as national reference, the NMCP report in DRC estimating 70% the LLIN use rate in 2014 nationwide. From there on, the sample size was computed as following:

$$n = \frac{z^2 \times P \times Q}{d^2} = \frac{[1.96]^2 \times 0.70 \times 0.30}{[0.05]^2} = 323$$

n: sample size; Z: confidence coefficient (1.96); P: LLINs use proportion in DRC as of 2014 (70%, 0.70); Q: 1-P = 0.30; d: statistical precision (0.05).

In order to find out how many students to survey within each corridor, the computed sample size (323 respondents) was divided by the overall number of corridors (61), which resulted in 5.3 students to survey per corridor. This number was rounded at 6 students per corridor, allowing the survey to cover an overall number of 366 respondents, obtained by multiplying 6 respondents within each corridor by 61 existing corridors. This rounding, by adding up to 10% of respondents upon the initial computed sample, allowed the survey to minimize the selection bias and to cover cases of non-response, if any. Respondents were randomly reached thanks to a multi-stage sampling process. The first stage consisted of stratification of student residences into female residences and male residences. Afterward, the second stage consisted of a simple random selection of six rooms in every single corridor within each residence. Finally, the last stage consisted of a simple random selection of one respondent per retained room. In this way, the study ensured that the sample under consideration is broadly representative of the study population.

Data Collection Procedures

In order to fulfill the assigned objective and address the research questions, the study entailed a survey questionnaire planning. This questionnaire took into account different variables to enquire, according to the conceptual framework depicted in Figure 1. It has been validated by a public health expert in health economics from the Public Health School of the University of Kinshasa and pre-tested amongst students. The study comprised ITNs possession and use as dependent variables, influenced by ITNs supply, demand and type of market as independent variables. ITNs demand comprised the price of ITNs, available income, price of substitute products, personal preferences, and special influences as determinants. ITNs supply was made of such features as the price, production conditions, price of substitute products, and special influences. ITNs type of market presented such characteristics as atomicity, products homogeneity, law of supply and demand applicability, access freedom, and transparency.

Socio-demographic characteristics of respondents were not taken into account since the study was focusing on the economic aspects of ITNs possession and utilization on one hand, and on the other hand, due to the fact that all respondents have almost the same socio-demographic characteristics: they are almost all included within the same age interval (young adults), have the same occupation (student), have the same education level (university level), have the same marital status (overwhelmingly, if not exclusively, single) and live in the same area (student residences of the UNIKIN). The questionnaire was straightforward addressed to the respondent in order to provide, if needed, any further enlightenments and to minimize the non-response rate. To avoid

respondent duplication, the lodging card was required to confirm the occupation of the room by the respondent, since a student can only rent one room during an academic year. Nonetheless, personal information displayed on the said card was not recorded in line with the anonymous character of the survey for confidentiality purposes.

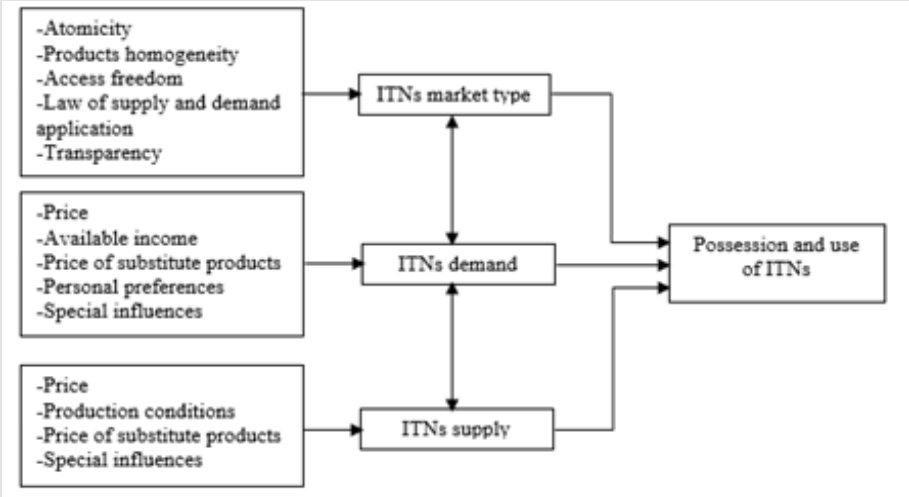

Figure 1: ITNs Supply and Demand Model [1].
Adapted from Mvudi, S. M. (2014). Health Economics. University of Kinshasa, DRC.

Data Analysis

Data collected from the survey were computerized thanks to EpiData 3.1 and analyzed with SPSS 21.0. The study was basically a qualitative one, bringing out students' perception on ITNs demand, supply, and type of market. Nonetheless, students' responses were quantified and presented in frequencies and percentages, in regard with the overall number of respondents.

Ethical Considerations

An authorization statement prior to the survey was obtained from the Deputy Dean Office in charge of Research, Specialization and Aggregation of Medicine School of the University of Kinshasa. Nevertheless, an ethical committee approval was not applicable. The survey was conducted after the oral obtention of an informed consent, the anonymity ground of respondents during the study was guaranteed and data were kept confidential.

Results

Distribution of Respondents by Residences

Thanks to a door-by-door survey conducted, we realized a response rate of 100% since every selected student accepted to participate. The number of corridors varies from a residence to another. As such, the number of respondents varies from a residence to another accordingly. The repartition of respondents, as surveyed per residence, is presented in Table 1. It was noted that, out of 366 respondents, 96 (26.2%) were from Home Plateau, while the same number of 54 (14.8%) was recorded for each Home X, Home XX, and Home XXX, a subtotal of 258 (70.6%) respondents from male residences. From female residences side, an identical number of 36 out of 366 respondents (9.8%) was noted for each residence, a subtotal of 108 (29.4%) respondents.

Table 1: Respondents repartition.

	Male residences			
	Blocs	**Corridors**	**n**	**%**
Home Plateau	8	16	96	26.2
Home X	3	9	54	14.8
Home XX	3	9	54	14.8
Home XXX	3	9	54	14.8
Subtotal	17	43	258	70.6
	Female residences			
	Blocs	**Corridors**	**n**	**%**
Home Vatican	2	6	36	9.8
Home 150	2	6	36	9.8
Home 80	2	6	36	9.8
Subtotal	6	18	108	29.4
Total	23	61	366	100

Possession and Use of ITNs

The ITNs possession and use rates are brought out in Table 2 which demonstrates that, of 366 respondents, 136 (37.2%) owned an ITN during the survey and could show it to surveyors, and only 106 (29.0%) spent the night preceding the survey under an ITN within student residences.

Table 2: ITNs possession and use.

	Options	n	%
The respondent owns at least one ITN in their room	Yes	136	37.2
	No	230	62.8
Respondent who has spent previous night under ITN	Yes	106	29.0
	No	260	71.0

Perception on ITNs Demand

Respondents' perception on ITNs demand is presented in Table 3. As shown, 214 (58.5%) respondents affirmed they would not buy an ITN even though its price decreases. A large number of students (62.3%) stated not willing to buy an ITN even if their subsistence fees were raised up. If the price of substitute products decreases, 207 (56.6%) respondents would buy substitute products instead of ITNs. Up to 244 (66.7%) respondents were ready to buy an ITN if their preferences towards ITNs were increased; and in the presence of special influences, 196 (53.6%) respondents affirmed that they would still not buy an ITN.

Table 3: Perception of respondents on ITNs demand.

	Options	n	%
Willingness of buying an ITN if its price decreases	Yes	152	41.5
	No	214	58.5
Willingness of buying an ITN in case of income increase	Yes	138	37.7
	No	228	62.3
Willingness of buying an ITN if substitute products price decreases	Yes	159	43.4
	No	207	56.6
Willingness of buying an ITN if consumers' preference increases	Yes	244	66.7*
	No	122	33.3
Willingness of buying an ITN if special influences come into existence	Yes	170	46.4
	No	196	53.6

Note: *Factor likely to foster ITNs acquisition and use

Perception on ITNs Supply

ITNs supply, as perceived by students in residence hall, is provided through Table 4. The survey revealed that, according to 212 (57.9%) respondents, ITNs supply would increase if its price were raised up. Moreover, 256 (69.9%) surveyed stressed that ITNs supply would increase if their production conditions were improved. If the price of substitute products were raised up, ITNs supply would increase, according to 275 (75.1%) respondents. Finally, 245 (66.9%) respondents perceived ITNs supply as increasing in the case of existing special influences.

Table 4: Perception of respondents on ITNs supply.

	Options	n	%
Increase of supply if the price of ITN raises up	Yes	212	57.9*
	No	154	42.1
Increase of supply if production procedures were improved	Yes	256	69.9*
	No	110	30.1
Increase of supply if substitute products price were increased	Yes	91	24.9
	No	275	75.1*
Increase of supply in case of special influences	Yes	245	66.9*
	No	121	33.1

Note: *Factors likely to demotivate ITNs acquisition and use

Perception on ITNs Type of Market

Factors defining the type of market are addressed in Table 5. As for 252 (68.9%) respondents, there is atomicity within ITNs market. On the contrary, up to 226 (61.7%) respondents perceived ITNs in the marketplace as inhomogeneous. In the same line, 197 (53.8%) respondents stressed that access to ITNs is restrictive. The price of ITNs within the marketplace is fixed without taking into account the law of supply and demand, from 265 (72.1%) respondents' viewpoint. An overwhelming number of 346 (94.5%) respondents qualified ITNs market as lacking transparence.

Table 5: Perception of respondents on market type.

	Options	n	%
There is atomicity in the market	Yes	252	68.9
	No	114	31.1
Products are homogeneous	Yes	140	38.3
	No	226	61.7*
There is free access to market	Yes	169	46.2
	No	197	53.8*
Law of supply and demand is applied	Yes	102	27.9
	No	264	72.1*
There is transparency in the market	Yes	20	5.5
	No	246	94.5*

Note: *Factors making ITNs market unattractive

Discussion

After collection, the present study analyzed ITNs coverage, use, and perception of supply, demand, and type of market among students from the University of Kinshasa student residences. As brought out, ITNs coverage and use rates are very low among students. Moreover, the perception of students, loosely speaking,

is unlikely to further ITNs possession and utilization. The study found 37.1% and 29.0% as ITNs rates of coverage and utilization respectively among students, answering the first research question. This situation is really alarming, just not to say drastic, compared to the WHO targets set up in line with its malaria control strategies [1]. In Nigeria, Adeneye, et al. [8] found a rate of 23.6% for both possession and use of ITNs, as lower as our findings. In such a country as the DRC where malaria is an ubiquitarian endemic, these low rates of ITNs coverage and use constitute an utmost exposition of the population under consideration vis-à-vis the disease. The worst side is mostly related to socio-economic consequences of malaria such as absenteeism in classes, exams missing, and failure due to insufficient preparation for students who need to be healthy to attend classes and address their assignments successfully. All factors influencing the use of ITNs need to be taken into account so as to improve these rates and encounter the WHO targets.

A proportion of 58.5% respondents were unwilling to buy ITNs even though its price was cut off. This entails that the price of ITNs does not constitute an obstacle to their acquisition on one hand, and that price reduction is not likely to promote ITNs use on the other hand. Same observations were noted by other authors. This is the case with Adeneye and his colleagues who found that 84.2% of respondents were willing to buy a ITN at an expensive price [7]. In the same line, 62.3% of respondents would still not buy a ITN even if their subsistence fees were increased. This reflects their unwillingness to acquire ITNs irrespective of their income. Other researchers supported that an increase in available income is likely to foster the use of ITNs. It is the case with Tchinda, et al. [20] in Cameroun who found that households with higher economic status were 3.32 more likely to use ITNs. If the price of substitute products such as IRS and antimalarials, were cut off, 56.6% of surveyed students affirmed they would seek these products in the expense of ITNs. A decrease in substitute products price is then likely to decrease the use of ITNs. Same observation was made by the Agence Nationale de la Statistique et de la Démographie (ANSD) in Senegal whose results disclosed that 55.2% of households with higher incomes preferred to use substitute products in malaria prevention instead of ITNs [21]. If their preferences, for instance in terms of colors or shapes, vis-à-vis ITNs were increased, 66.7% respondents stressed they would seek this material to prevent malaria. This implies that attractiveness of ITNs is likely to increase their use.

Of all respondents, Alfonso, et al. [22] have found that 43.8% of households expressed the will of purchasing ITNs with special features. Fernando, et al. [23] also reported an increase of use related to the shape of ITNs. Even during such periods as the rainy season where it has been noted an increase in mosquitos' bites, 53.6% respondents are still not willing to seek ITNs. The existence of special influences is then unlikely to increase the use of ITNs. Likewise, Adeneye, et al. [8] reported that only 49.1% of respondents prefer ITNs to other means in malaria control. Our results were, however, the opposite of those found by Sangaré [24] who stated that 54% of households preferred to use ITNs during the rainy season rather than the dry season. In sum, among all factors numbered, only an increase in attractiveness is likely to foster the demand and thus, promote the use of ITNs, answering the second research question. It showed off as a factor to be exploited in order to boost the acquisition and use of ITNs. The attitude and intention of ITNs suppliers may be determinant in the use of this material. As mentioned, some sections backwards, ITNs supply should better show off, although commercialized, as an activity prioritizing health of consumers. Otherwise, meaning when suppliers are perceived as profits seekers, consumers may become, out of mass distribution campaigns, retractive to acquiring and using ITNs, so that suppliers may not maximize profits on their expense. The study surveyed students about their perception on ITNs supply. As for 57.9% of respondents, ITNs supply would increase if the price were raised up. This means that suppliers are only focusing on their profits. In contrast, Pukakwey [25] found different results in its study were only 43.6% of respondents thought that health services supply would increase if the price were raised up.

ITNs supply will increase, consecutively to production procedures improvement, according to 69.9% surveyed students. As such, suppliers are perceived as taking profit of production costs reduction to maximize benefits. Likewise, respondents think, up to 75.1%, that suppliers would abandon offering ITNs if there were any increase in substitute products price. From this point of view, suppliers are perceived as opportunists, seeking the most paying business to jump on. Hence, they seem not caring about the benefic effects of ITNs, looking for profits they would make by supplying those expensive goods, which is unlikely to promote the use of ITNs. As for 66.9% respondents, ITNs supply would increase in presence of special influences such as rainy season when suppliers are sure about maximizing their profits. In sum, the survey respondents perceive ITNs suppliers purely as profits seekers, increasing supply if and only if their own interests are guaranteed, answering the third research question. This will entail a retractive attitude from students to buy ITNs from commercial sector between mass distribution campaigns, reducing its rate of use. Public health professionals can improve the use of ITNs by changing these perceptions through vulgarization campaigns. Fairness is an important feature attracting sellers and buyers into a market where everyone from their side feels at-ease and not abused. A market is said fair when it is a perfectly competitive market, encountering such criteria as, but not limited to, atomicity, products homogeneity, access freedom, law of supply and demand application, and transparence.

A market that misses one of these features is said an imperfect competitive market. Surveyed upon this topic, 68.9% students think that there is atomicity within ITNs market, which means any buyer nor seller cannot, simply by their own will, influence market trends. This makes a market a reliable one because there is fairness. In the opposite, 61.7% of respondents think there is no products homogeneity, meaning ITNs features vary from a seller to another, and 53.8% think there is access restriction, meaning there are some requirements for news sellers to enter the market. Up to 72.1% think that the law of supply and demand is not applied, meaning ITN price is fixed without taking into account the principle of number of buyers counter amount of good to be sold, and 94.5% think there is no transparence, meaning there is a group of individuals who keep information or take profits on the expense of others. Therefore, ITNs market is perceived as an imperfect competitive market, answering the fourth research question. As implications, there is unattractiveness of consumers towards this market, which reduces ITN use. Public health professionals and decisions makers need to improve these aspects of market by implementing new policies in order to improve market conditions and thus increase ITNs use, even though perfect competition is virtually hypothetical in real life.

Conclusion

The study has introduced a new approach in examining economic determinants of ITNs coverage and use. The demand of ITNs is likely to be increased if features attractiveness is enhanced. On the other hand, suppliers' intentions, as negatively perceived by consumers, seem to impact the coverage and use of ITNs. Such intentions as increasing ITN production when its price increases, when production procedures are improved, or when special influences come into existence in order to maximize profits decrease the acquisition and use of ITNs since suppliers are seen not as prioritizing people health state, but their own interests. Likewise, ITNs market, considered imperfect competitive, is unlikely to attract buyers and sellers, thus cannot foster ITNs use. All this can be a logic explanation to the lower use of ITNs among students. Public health professionals should take into account these aspects of ITNs use determinants while developing interventions in malaria control. They can enhance ITNs attractiveness to increase the demand, sensitize populations about their perception on ITNs supply, and improve ITNs market conditions so as to increase the acquisition and use of this precious material through commercial sector between mass distribution campaigns and control malaria effectively.

Strengths and Weaknesses

The target population was so selective, with so peculiar characteristics that it may seem difficult to generalize our findings over the rest of populations. Moreover, as a descriptive and qualitative study, this paper did not establish existing correlation between negative perception on supply, demand, market type, and low rate of ITN use. In other words, the study aimed at introducing new approach in ITNs use determinants and generating hypothesis that further studies can verify. Nevertheless, the study has a merit relative to two aspects. First of all, this is, to our knowledge, the first study to determine the rates of ITNs coverage and use among students within student residences at the University of Kinshasa, if not nationwide. Secondly, this is one of rare studies, if not the only one, to exclusively evaluate ITN economic aspects in terms of supply, demand, and type of market.

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Conflict of Interest

Author discloses no conflict of interest.

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