

Consumer willingness to pay for a hypothetical chikungunya vaccine in Brazil and the implications

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Abstract

Background: Chikungunya fever is an important infectious disease transmitted by the bite of the mosquitoes. Information about consumers' willingness to pay (WTP) for a hypothetical vaccine can help with future discussions about its possible price. Methods: A

cross-sectional study conducted among residents of Minas Gerais, Brazil, regarding their WTP for a hypothetical chikungunya vaccine defined by the authors as having a mean effective protection of 80%. Results: We interviewed 496 individuals. Among these, 23 were excluded from the analysis. Most of the respondents were female (57.3%), had completed at least high school (90.7%), were employed (87.7%) and had private health insurance (62.6%). The median value of the WTP was US\$ 31.17 (120.00 BRL) for a unique dose vaccine. The WTP showed a statistical significant correlation with monthly family income and access to private health insurance. Conclusion: This study can contribute to decision-making about potential prices for a chikungunya vaccine once it becomes available in Brazil. We demonstrated the relevance of the anchoring effect as a possible influence applied to the maximum value of the WTP associated with respondents' preference for a new vaccine. Finally, we encourage the development of a chikungunya virus vaccine to benefit the Brazilian population.

Keywords: willingness to pay; chikungunya; vaccine; consumers, Brazil.

1. INTRODUCTION

Chikungunya fever is an infection caused by the Chikungunya Virus (CHIKV), a member of *Alphavirus*, and transmitted to humans by the bite of mosquito of the *Aedes* genus, especially *Aedes aegypti* and *Aedes albopictus* [1]. The first described cases of CHIKV occurred in 1952 during an explosive outbreak on the Makonde Plateau in the Southern Province of Tanganyika (Tanzania) [2]. It is known that the incubation period varies from two to seven days [3], and the symptomatology can occur in 2 phases: acute and chronic. In the acute phase, the most common symptoms are fever (temperature > 38.9°C), headache, nausea, vomiting, fatigue, myalgia and symmetric arthralgia [3]. Another predominant symptom is a cutaneous rash [4]. This phase has a short duration. The chronic phase is characterized by persistent joint pain and can last for months [4]. Brito *et al* (2017) has shown in a recent study that 75-95% of individuals infected by CHIKV have clinical manifestations (acute or chronic), and that chikungunya has a mortality rate of 1.3/1000 [5].

The Pan American Health Organization (PAHO), the south-American regional office of the World Health Organization (WHO), estimated 2,673,671 cases between December 2014 and December 2017, with an average of 55,701.48 cases per month in America [6]. This arbovirus has now spread to Asia and other regions following the outbreak in Tanzania [7-10] and, in the past decade, cases have been identified even in developed countries including the outbreaks in Italy in 2007 and 2017 [11-14]. CHIKV has established its transmission cycle in different regions in the Americas, Southeast Asia, Indian Ocean Islands and India, as well among European countries including Italy and France [10, 13, 15]. Currently, CHIKV is widespread throughout tropical and subtropical countries, with risk factors including local spatial variations of rainfall, temperature, relative humidity, and the quality of vector control services in urban areas [1, 3].

In Brazil, infection by the CHIKV became a national public health priority in 2016 with 277,882 registered cases, with appreciable social, clinical and economic impact in Brazil [10]. In accordance with the National Information System of Notifiable Diseases (SINAN), there have been 271,075 cases since 2017 (185,854 in 2017 and 85,221 in 2018) [10].

Currently, there is no specific treatment to control this infection. In this scenario, a potential vaccine for CHIKV would appear to be a good alternative to avoid the illness spreading and protect the Brazilian population from the symptoms of chikungunya. This is similar to the situation for dengue fever and Zika [16, 17]. Whilst no vaccine is currently available to prevent chikungunya fever, some candidates have shown good results in Phase I studies. The Vaccine Research Center (VRC) candidate, the VRC-CHKVLP059-00-VP, a virus-like particle (VLP) vaccine has shown in Phase I good safety, tolerability and immunogenicity [18]. However, its Phase II results have not yet

been published [19]. Some other vaccines are also being developed, including MV-CHIK and CHIKV VLP, both of which are also now in Phase II studies [19]. Consequently, it is probable that in a few years some of these vaccines will be available on the market.

Once the vaccine is formally registered in The Brazilian Health Regulatory Agency (ANVISA), it already may be marketed in the country. The price of the medicine must be below the ceiling value determined by the Brazilian Drugs Market Regulation Chamber (CMED) to be reimbursed within the public health care system. In the case of a CHIKV vaccine, the medicine would be classified in category I, a new product with a patent in the country. This means that the ceiling price can not exceed the lowest price in a number of selected countries including Australia, Canada, France, Greece, Italy, New Zealand, Portugal, Spain, and the United States of America, to be considered for possible reimbursement [20]. After price determination, pharmaceutical companies may request the incorporation of their products into Brazilian public health system (SUS), a process managed by the National Commission on Technology Incorporation of the National Health System (CONITEC) [21]. Companies should typically incorporate economic evaluations, including any willingness to pay (WTP) study conducted among the Brazilian population, into their submissions to assist with decision-making [21]. This becomes essential for new medicines launched first in Brazil among the reference countries, which is likely to be the case for this vaccine [16, 22]. WTP studies conducted by our research group facilitated in pricing negotiations for a new vaccine for dengue [23], and we expect this to continue for any CHIKV vaccine.

WTP is a measurement technique that estimates the maximum value respondents are able to pay for a given health technology [24]. Several studies using this approach have been associated with hypothetical vaccines including a vaccine for dengue [25-27],

HIV infection [28], malaria [29], ebola [30] and Zika [16, 31]. This methodology can contribute to discussions about the potential prices for new vaccines, along with other national measures to control current viruses in endemic countries such as Brazil that also have financial implications. Consequently, the aim of study was to estimate the Brazilian consumers' WTP for a hypothetical CHIKV vaccine. The findings could contribute to any discussions about potential prices for a future vaccine with known attributes as well contribute to discussions for the future incorporation of any such vaccine into the Brazilian public health system.

2. MATERIALS AND METHODS

This study was conducted with Brazilian consumers to ascertain their WTP for a hypothetical CHIKV vaccine, that is, the maximum amount they are prepared to pay to acquire the product [32]. Only respondents aged 18 years or older who were without the disease at the time of interview were able to take part in this study. This is because in Brazil those aged 18 years or older are legally responsible for their actions [33]. For this reason, we invited only those individuals with this age profile to take part in this study. However, they may or may not have had chikungunya in the past [24].

2.1 Design and study location

The survey was undertaken in the metropolitan region of Belo Horizonte, which is the capital of Minas Gerais State. Minas Gerais currently has 19,597,330 inhabitants, making it the second most populous State in Brazil [34]. Socioeconomic aspects are very similar between Minas Gerais and Brazil as a whole suggesting reasonable representation, with a mean Human Development Index (HDI) of 0.731 and 0.737 in 2010, respectively [35]. Another similarity is the mean income per capita, being US\$315.97 for Brazil and US\$311.76 for Minas Gerais per month in 2015 [35].

Undergraduate pharmacy students of the School of Pharmacy of the Federal University of Minas Gerais undertook the survey between May and June 2018. These students were previously trained to conduct the interviews. The questionnaire used during the interviews was developed by the research team, and similar to other published studies from the research team in Minas Gerais and other countries [16, 22, 24, 36].

2.2 Data collection instrument

To assure all respondents had a satisfactory level of knowledge about the disease, the interviewers provided information of all relevant features of CHIKV infection and its clinical context (contained in the Supplementary Material). . After explaining about CHIKV infection, the interviewers asked a number of questions in face-to-face interviews about the disease to ascertain if the information provided was clear. The interviewers also answered all requests of information from the respondents to enhance the robustness of the findings.

The questionnaire was consisted of five sections: (1) questions to ascertain previous knowledge about the disease among the respondents; (2) information about the disease and the hypothetical vaccine; (3) questions to verify the comprehension of the respondents about the information given; (4) discrete choice, bidding game and open-ended questions; and (5) a self-reported socioeconomic section. The aim of section four was assess whether individuals would be willing to pay an initial value that was presented as well as obtaining the maximum value respondents would pay for this hypothetical vaccine.

As mentioned, we used three techniques to estimate the WTP including discrete choice, bidding game and open-ended questions. Discrete choice experiment (DCE) is a quantitative method that tries to assess the preferences of the individuals without asking

it directly. In DCE, participants are presented with two or more hypothetical scenarios and have to choose between them. [24, 37, 38]. In the bidding game technique, individuals are asked if they are willing to pay a specific value and, if so, the values are doubled until the participant is no longer willing to pay this amount. However, if the participant is not willing to pay, the values are divided by half until the individual is willing to pay this amount. In open-ended questions, participants are directly asked about a specific subject. In case of our study, the question was about the maximum value they were WTP for a hypothetical chikungunya vaccine [24].

The central value (US\$46.75 or 180.00BRL) applied to the discrete choice approach was selected based on the price for a vaccine against yellow fever, building on previous studies [16, 22]. The bidding game approach utilized in our study involved five starting points: US\$11.69 (45.00BRL), US\$23.38 (90.00BRL), US\$46.75 (180.00BRL), US\$93.51 (360.00BRL) and US\$187.90 (720.00BRL). In other words, we developed five types of questionnaire (Supplementary Material) and the only difference between them was the bidding game section, where each instrument had one of the starting points previously mentioned. We included this aspect in the instrument to allow the discussion about the anchoring effect present in bidding game techniques [16, 22, 39]. The values used as starting point in the bidding game approach were defined as one quarter (45.00 BRL or US\$ 11.69), half (90.00 BRL or US\$ 23.38), double (360.00 BRL or US\$ 93.51) and quadruple (720.00 BRL or US\$ 187.80) the central value (180.00 BRL or US\$ 46.75).

Our study differs from the majority of other published studies which generally use only one value in the bidding game section of the instrument [16, 22, 39]. We realise this strategy is not common; however, the use of more than one value as a starting point is already being used in WTP assessments [40] and was undertaken in this

study to try to remove the anchoring effect present in bidding game techniques [41]. We also wanted to demonstrate the possible influence related to the WTP for this new hypothetical vaccine according to the initial value (starting point applied to the bidding game technique) presented to the interviewee. For this study, we hypothesized that the vaccine would have an efficacy of 80% along with adverse effects including pain on application site, swelling and other local symptoms, as well as systemic symptoms including possible fever, myalgia and headaches. A figure was used to clarify the efficacy of the vaccine with interviewees.

2.3 Sampling and selection criteria

Participants were interviewed in multiple parks, squares, markets and fairs in the metropolitan region of Belo Horizonte, each one with different socioeconomic characteristics, with the objective of reducing possible selecting bias. We have successfully used this approach in previous WTP studies conducted among our research group [16, 22]. As before, taking part in the study was voluntary. The minimum number of participants required in this research was 400, considering that 50% of respondents would agree to pay the value of US\$46.75 (180.00BRL), with a margin of error of 5% to a 95% confidence interval, which results in $1/(0,05^2) = 400$.

All selected participants declared having an income. Individuals who showed WTP higher than twice their declared monthly income and those who would not use the vaccine even if provided free were excluded. This was because Haab & McConnell (2002) through parametric models for contingent valuation had demonstrated that to measure meaningful WTP values, individuals need to present a non-negative value as a lower bound and an upper bound not greater than their current income [24]. These aspects were also considered in previous studies [16, 22]. Respondents could or not

have private medical health insurance. However, the minority of Brazilians who currently purchase private insurance may still access public services if they need or want to in Brazil [42]. Infectious diseases including chikungunya, dengue, yellow fever, and Zika, are diseases with mandatory notification to SINAN regardless if patient access the private or public health systems [43].

2.4 Data analysis

The WTP for this hypothetical chikungunya vaccine was estimated by the median of the answers of all individuals who were prepared to pay any amount greater than or equal to zero (non-negative, i.e. would only use if free of charge) but less than twice their declared monthly income. As a result, all the respondents who were unwilling to be vaccinated even if the vaccine was free were excluded from the analysis. To compare the median values between the groups defined by covariates, we used the Mann-Whitney test (two groups) and the Kruskal-Wallis test (three or more groups). The significance level was set at 5%. The "bivariate" analysis was applied to WTP, and for each explanatory variable in our study this allowed us to describe the factors that individually affect the WTP, similarly to previous publications [16, 22]. The choice of the medians rather than means was made due to the extreme asymmetry characteristic of the WTP distribution, which requires the use of methods not parameterized in Normal and that do not compare averages [24]. Haab & McConnell (2002) had previously demonstrated that the difference between median and mean willingness to pay can be considerable when the variance is high, observing that the mean willingness to pay increases the variance of the error [24].

The socioeconomic and inherent variables were evaluated and their effect on WTP was measured. We compared the values of WTP with variables of age, gender, education level, work, and the monthly income of the respondents as well as the initial

value of the vaccine (the starting point applied with the bidding game technique). To assess the income variation, the sample was stratified by the values of “< 1”, “1-5” and “>5” times the minimum wage (MW) in order to have a clearer comparison between the subgroups. As mentioned, we used median values instead of mean values to reduce the influence of outliers. Minitab 17 and Microsoft Excel 2016 were the software programmes we used to perform this analysis. The currency conversion value we adopted was US\$ 1 = 3.85 BRL [44].

2.5 Ethics statement

Before being interviewed, individuals read and signed the *Term of Free and Clarified Consent*. All researchers of the project signed a confidentiality agreement before taking part in the interviews. The Ethics Committee of the Federal University of Minas Gerais (COEP) under the CAAE 57219816.0.0000.5149 approved this study.

3. RESULTS

3.1 Population characteristics

We conducted 496 interviews with individuals aged between 18 and 100 years old who agreed to participate and answer the questionnaire, with a mean age of 35.3 ± 1.2 years. Of the 496 individuals, 57.3% were female, 87.9% had employment at the time of the interviews and 90.7% had completed at least high school (Table 1).

Only 1.8% of the respondents reported a previous case of Chikungunya in their family. In 54.6% of those interviewed, their family income was between 1 and 5 times the minimum wage.

Table 1. Characteristics of the respondents (n= 496)

Variable	N	%
Age in years [mean (SD)]	35.3	(1.2)
Women	284	57.3
Has children	224	45.2
Education level		
Had never attended school	1	0.2
Completed elementary school	29	5.9
Completed high school	171	34.5
Completed college or more	154	31.1
Currently working	436	87.9
Have private health insurance	311	62.7
Had chikungunya	3	0.6
Reported that other people in the household had chikungunya	9	1.8
Family income (number of minimal wages*)		
Less than 1	27	5.4
1 to 2	77	15.5
2 to 3	70	14.1
3 to 5	124	25.0
5 to 10	112	22.6
10 to 20	44	8.9
More than 20	9	1.8

Note: *Brazilian minimal wage in 2018 was 954.00 BRL (US\$ 247.79) monthly

Out of 496 individuals who participated in our study, fourteen were excluded because they would not accept the vaccine even if it was available free of charge. Eight individuals reported having chikungunya at the time of the survey and were therefore also excluded from the analysis. One individual was excluded for reporting a WTP greater than twice their income. As a result, 23 individuals were excluded resulting in 473 individuals subsequently taking part. Out of these, 57.3% were women, 90.7% had completed high school or more, 45.7% had children, 87.7% had employment at the time of interview, 62.6% had private medical health insurance and only 1.9% had a housemate who had chikungunya in past similar to the characteristics of the initial 496 individuals (Table 1).

3.2 Willingness to pay for a hypothetical chikungunya vaccine

The WTP for this hypothetical vaccine among the Brazilian consumers was estimated at a median value of US\$ 31.17 (120.00 BRL) (Figure 1). This means that 50% of the individuals reported maximum values of WTP equal or less than US\$ 31.17.

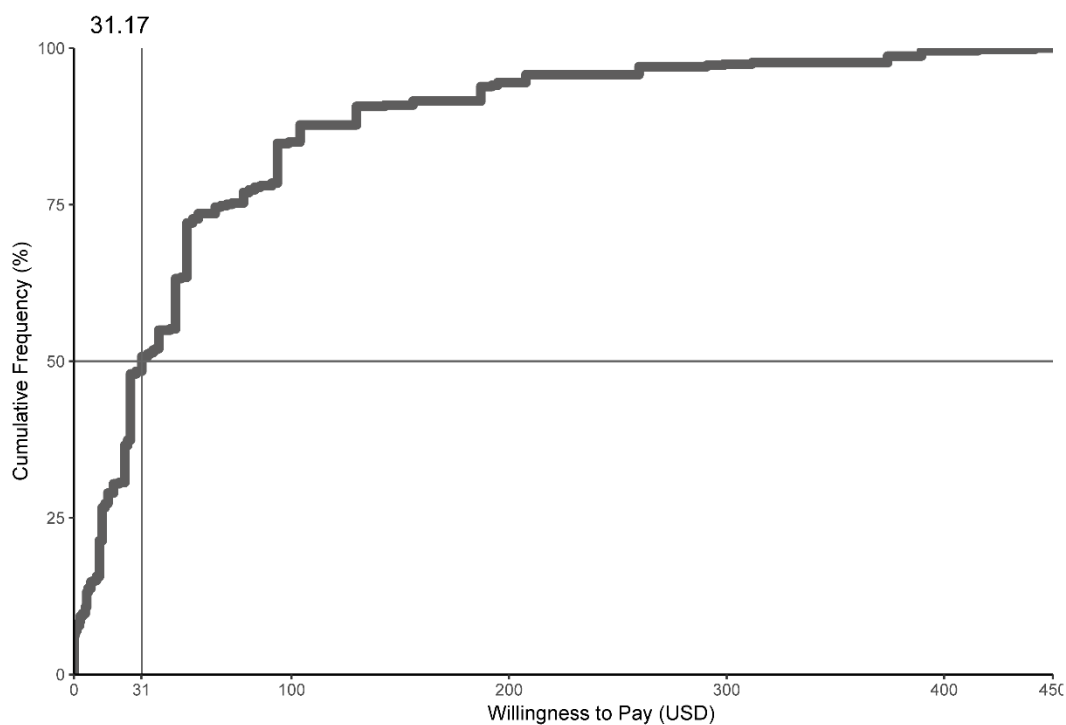


Figure 1. Cumulative frequency of the maximum value of WTP of a hypothetical chikungunya vaccine

Three variables presented statistical significance (p -value < 0.05) in relation to WTP. These were monthly family income (MFI); the Initial Value of the vaccine (InV) (or starting point applied in the bidding game technique); and people who had private health insurance. The MFI variable was stratified as “ < 1 ”, “1-5” and “ > 5 ” times the minimum wage, representing family income values under US\$ 247.80 (954.00 BRL), between US\$ 247.80 (954.00 BRL) and US\$ 1238.96 (4770.00 BRL) and above US\$ 1238.96 (4770.00 BRL), respectively. Median values of WTP for these groups were, respectively, US\$ 12.99, US\$ 25.97 and US\$ 46.75 (Figure 2). The p -value for monthly family income was 0.011. As mentioned before, the InV used in the questionnaires

were: US\$ 11.69 (45.00BRL), US\$ 23.38 (90.00BRL), US\$ 46.75 (180.00BRL), US\$ 93.51 (360.00BRL), and US\$ 187.90 (720.00BRL). The WTP measured for these values were: US\$ 25.97 (100.00 BRL), US\$ 25.97 (100.00 BRL), US\$ 41.56 (160.00 BRL), US\$ 46.75 (180.00 BRL) and US\$ 46.75 (180.00 BRL), respectively, as shown in Table 2. The p-value for this variable was 0.002. The InV (or starting point applied in the bidding game technique) variable correlated statistically with WTP (<0.05), as shown in Table 3.

Regarding private health insurance, people who had private health insurance were willing to pay US\$ 46.75, while people who did not have private health insurance were willing to pay US\$ 25.97. The p-value for this variable was 0.0197. No statistical significant ($p > 0.05$) differences were found when comparing the values of WTP with variables of age, gender, education and employment.

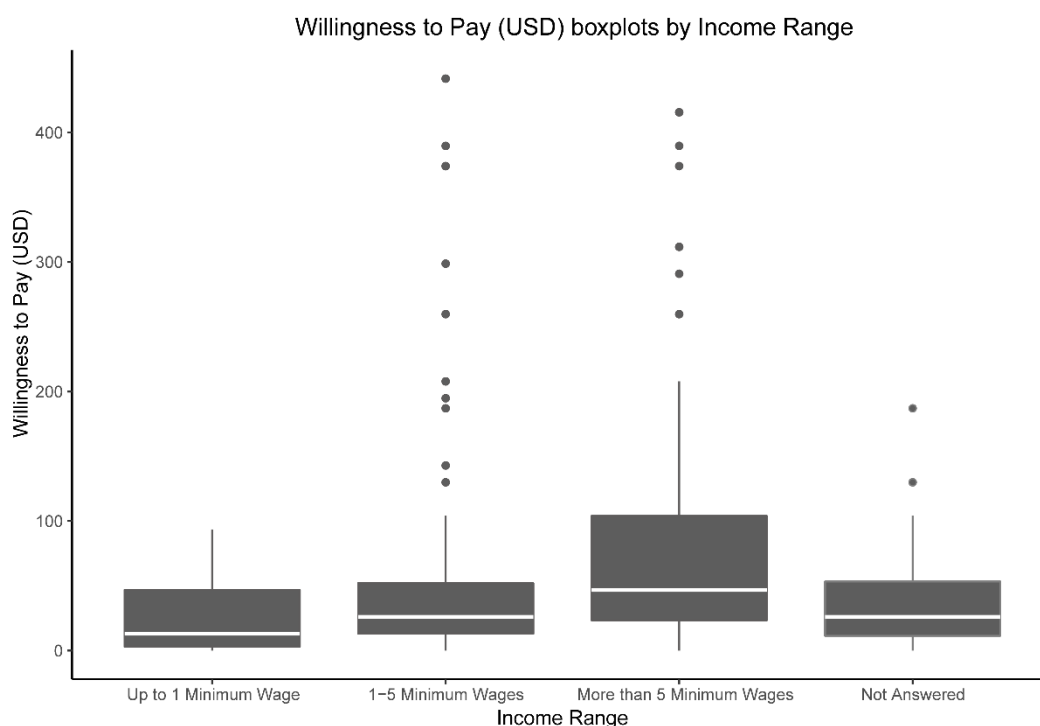


Figure 2. Box plot of willing to pay (US\$) for a hypothetical chikungunya vaccine according to the income range.

Table 2. WTP according to socioeconomic characteristics (n= 473)

Variable	WTP
Monthly family income [§] (p = 0.011)	
Less than 1	US\$ 12.99
1 to 5	US\$ 25.97
More than five	US\$ 46.75
Initial value of questionnaires* (p = 0.002)	
45.00 BRL (US\$ 11.69)	US\$ 25.97
90.00 BRL (US\$ 23.38)	US\$ 25.97
180.00 BRL (US\$ 46.75)	US\$ 41.56
360.00 BRL (US\$ 93.51)	US\$ 46.75
720.00 BRL (US\$ 187.90)	US\$ 46.75
Access to private health insurance (p= 0.0197)	
Yes	US\$ 46.75
No	US\$ 25.97

[§]Monthly family income represents the number of minimal wages (BRL)

*: The starting point of the bidding game technique applied in our study.

Table 3. Willingness to accept the vaccine according to the initial value presented to the respondents

Variable	Acceptance
45.00 BRL (US\$ 11.69)	83.3%
90.00 BRL (US\$ 23.38)	58.5%
180.00 BRL (US\$ 46.75)	48.9%
360.00 BRL (US\$ 93.51)	35.4%
720.00 BRL (US\$ 187.90)	18.7%

*Note: The p-value was 0.002 in statistical analysis with this variable (Initial value of questionnaires)

4. DISCUSSION

We believe this is the first study to estimate the WTP for a hypothetical vaccine with 80% of efficacy against CHIKV in Brazil. Additionally, assess if a higher initial value on the bidding game could influence the WTP of the respondents to guide future studies and decision making [41].

Gender (p = 0.25) and age (p = 0.23) did not demonstrate statistical significance regarding the reported WTP for this hypothetical vaccine. These findings were similar to other studies conducted in Brazil estimating the WTP for a dengue vaccine [22] and a hypothetical Zika vaccine [16]. However, Javan-Noughabi and collaborators (2017) identified a statistical difference between WTP and gender; however, reinforced that the

findings changed with the context (service, intervention, and region of study) [45]. It is known that the epidemiological impact of a disease can affect the WTP [46]. Other variables that did not have statistical significance ($p > 0.05$) with WTP were a previous experience with the disease. This was surprising as it is known that personal experience with the disease can influence reported WTP [46].

The median estimated willingness to pay was US\$ 31.17 (120.00 BRL) as shown on Figure 1, which was the same value for a Dengue vaccine (DV) – US\$33.61 (120.00 BRL) [22]. This similarity of the WTP between the two vaccines shows a worry among the Brazilian population regarding the chikungunya infection given ongoing concerns with dengue [22, 47]. Consequently, a new vaccine should be welcomed at the right price.

Javan-Noughabi and collaborators (2017) in their study to identify determinant factors on WTP for health services in Iran verified that monthly income was a key determinant of WTP for preferences associated with health services ($p < 0.01$) [45]. This is similar to our study which demonstrated that monthly income was significantly associated (<0.05) with WTP. The minimum and maximum values in our study applied to WTP for a hypothetical chikungunya vaccine with 80% of efficacy was, respectively, USD 0 and USD 441.56 (1700.00 BRL) and the mean value was USD 58.88 (226.89 BRL). Consequently, we estimated the median of the maximum values of WTP for a hypothetical chikungunya vaccine (single dose) similar to other studies [16, 22, 38]. In addition, we demonstrated that the maximum value of WTP for this hypothetical vaccine was associated with the InV variable, with statistical significance (<0.05), suggesting that the price of a new vaccine can influence directly its acceptance [24].

Additionally, the WTP for chikungunya vaccine was greater than the value found for a hypothetical Zika virus vaccine (ZV) – US\$ 31.34 (100.00 BRL) [16]. This

higher value for a CHIKV vaccine can be explained by the more persistent and incapacitating symptoms of chikungunya compared with Zika, which can affect work capacity among other events. The influence of epidemiological and other characteristics on WTP can be seen by the values measured for influenza (I\$ 13.7) versus for instance HIV infection (I\$ 2321.2) [46], diseases with smaller and great morbidity respectively.

It is important to emphasize that this WTP is for a vaccine with 80% of efficacy. If, in the future, a vaccine is approved with a different efficacy, the WTP will likely be altered [28]. Consequently, in this scenario, adjustments will be necessary [32]. However, we believe our findings are a good starting point for future research.

Our results demonstrated that the WTP increases with a higher family income, as demonstrated on Figure 2, which is expected due the greater purchasing power inherent in those individuals as observed in other published studies [16, 22, 24]. Those with private insurance in Brazil are likely to have a higher income and expect and pay for early access to health services. In a middle income country such as Brazil, with a low value of GDP *per capita* compared to higher Western countries [48], it is extremely important that the prices of medicines be consistent with the people's income.

In our study we also observed the anchoring effect as a possible influence of InV on WTP, e.g., if there was just one initial value (US\$ 46.75 or 180.00 BRL) on the questionnaires, the WTP can be US\$ 41.56, a value 33.3% greater than that found with the multiple initial values (Table 2). Consequently, the absence of multiple InVs could result in the respondents giving more specific answers. We believe our results can be justified according to study by Furnham and Boo (2011) [41], who reinforced that this effect is an anchoring bias whereby people are influenced by specific information given before a judgement. This effect was not demonstrated and discussed in previous studies

undertaken to determinate the WTP for arboviruses vaccines [16, 22]. Consequently, we will be researching this further in future WTP studies.

Considering the initial values, it is possible to have an indication of the consumer's preference according to a future price of the vaccine. As shown in Table 3, it is noticeable that the percentage of people who were prepared to purchase the vaccine at lower values is larger than those at higher prices. This is expected as the price of a product is notably one of the variables most related to WTP as shown in other similar studies [46].

We are aware that there are limitations with this study. These include a potential bias in the study population. According to Smith and Noble (2014), selection bias relates to both the process of recruiting participants and the study inclusion criteria. The authors reinforced that successful research begins with recruiting participants with different participant profiles [49]. In addition, Pannucci and Wilkins (2010) demonstrated that prospective studies where the outcome is unknown at time of recruitment of the participants are less prone to selection bias [50]. To help address these issues, we recruited participants from a number of public places to try and involve respondents from all social, economic and education classes to decrease recruitment bias. However, we are aware that we may not have fully eliminated recruitment bias. For example, if we had recruited respondents in another region in Brazil associated with either a lower or higher chikungunya incidence, we may have seen different results with only 0.6% of respondents in our study previously having chikungunya. We also include a hypothetical vaccine with efficacy and values that may not reflect reality at the time any new product becomes available as observed in other studies [16]. The anchoring effect was one of the aspects evaluated in this study and the multiple initial values presented to the interviewees seem to help address this effect. However, it is not

possible to say that the anchoring effect was completely eliminated. Finally, we are aware that the participants may overstate their WTP when applying this kind of methodology (stated preference). This may occur because in stated preference research, interviewees do not come across budget constraints unlike in a real market scenario [51]. Despite these concerns, we believe our methodology was robust providing findings that are likely to be considered in future pricing negotiations once a vaccine becomes available, building on our findings with a dengue vaccine.

5. CONCLUSION

The WTP for a hypothetical chikungunya vaccine of US\$ 31.17 demonstrated the similarity between this and the other common arboviruses in the country such as dengue (US\$ 36.19) and Zika (US\$31.34). Consequently, we believe this study may encourage the Brazilian government and the pharmaceutical industries to accelerate the process of developing a chikungunya virus vaccine considering the epidemiological and clinical context. Additionally, it is expected that these data may help with discussions about possible prices of a future chikungunya vaccine in Brazil once this becomes available.

Whilst the methodology adopted estimates the maximum value individuals were willing to pay for a new hypothetical vaccine, we believe this study can contribute to future pricing discussions when the vaccine is launched in the private market and for the public system for possible incorporation in the SUS system. This is similar to the situation for the dengue vaccine and reinforces the necessity for companies to conduct WTP alongside other economic studies such as cost effectiveness analysis when considering applying for incorporation into SUS at agreed prices.

EXPERT COMMENTARY

In the coming years, there will be advances in the development of a chikungunya vaccine. A vaccine that is safe and effective to combat this disease will be welcomed. Economic studies such as these, combined with submissions from pharmaceutical companies, will help guide pricing and reimbursement discussions in Brazil for such vaccines to be incorporated into the Brazilian Public Health System. We will be monitoring the developments of new vaccines, which represents an important approach for endemic countries.

KEY ISSUES:

- In the last two years, there were 271,075 cases of chikungunya in Brazil. Since 2014, there have been 2,673,671 cases of chikungunya in the Americas.
- The infection by CHIKV usually causes fever (temperature $> 38.9^{\circ}\text{C}$), headache, nausea, vomiting, fatigue, myalgia, symmetric arthralgia and joint pain.
- The disease may occur in two phases: acute and chronic. The chronic phase can last for several months and its most common symptom is persistent joint pain.
- Although currently there is not a treatment specific for chikungunya, it is possible that in a few years vaccines against CHIKV will become available.
- This study estimated the willingness to pay (WTP) of Brazilian consumers for a hypothetical Zika vaccine through an analysis of contingent valuation.
- Fifty per cent of the interviewees, inhabitants of Belo Horizonte and its metropolitan area were willing to pay US\$ 31.17 (120.00BRL) for the hypothetical vaccine against chikungunya, the same value found for a dengue vaccine in other previous studies [12].
- We expect this study will provide data for any future discussions surrounding the introduction of a CHIKV vaccine into the Brazilian's Public Health System (SUS), as well as its pricing in both the private and public markets.

CONFLICTS OF INTEREST

The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

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