# Public’s willingness to pay towards a medical device for detecting foot ulceration in people with diabetes

**Running title:** WTP towards a medical device for diabetes

Fan Yang PhD1, Brenda Gannon PhD2,Andrew Weightman PhD3

1Centre for Health Economics, University of York, York, UK

2Centre for Business and Economics of Health, University of Queensland, Australia

3School of Mechanical, Aerospace and Civil Engineering, University of Manchester, UK

Corresponding to:

Fan Yang, PhD

Centre for Health Economics  
University of York   
Heslington, York

YO10 5DD, UK

Tel: +44 (0)1904 321491

E-mail: [fan.bella.yang@york.ac.uk](mailto:fan.bella.yang@york.ac.uk)

# Abstract

**Objectives** Diabetic foot ulceration (DFU) is a common and serious complication among diabetic patients. A medical device has been developed to prevent the occurrence of DFU. The aim of this study was to investigate the willingness to pay (WTP) for this device among the general public in the UK.

**Methods** A contingent valuation survey was administered to 1051 participants through an online survey including questions on socio-demographic characteristics, self-reported health, knowledge of diabetes and medical devices, and WTP. A two-part model was used to analyse determinants of WTP, including a logistic model in the first part and a generalised linear model with a log-transformed WTP in the second part.

**Results** More than half (55.9%) of the participants expressed a positive WTP. The annual mean (standard deviation [SD]) and median (interquartile range [IQR]) WTP values were £76.9 (69.1) and £50 (80), respectively. Older age, middle-level education, good/excellent self-reported health, visiting doctors once/2-5 times, diabetes experience, medical device experience, and more than average self-perceived likelihood of using similar devices were associated with higher likelihood of willingness to pay. Younger age, male gender and higher household income were associated with higher WTP values.

**Conclusion** This study demonstrated that people are willing to pay for this device and they tend to contribute when they have experience of diabetes or similar devices and perceive self-benefit.

# Key Points for Decision Makers

* A contingent valuation survey supported people’s willingness to pay for a device developed to prevent the occurrence of diabetic foot ulceration.
* Age, gender, education, health and income were associated with willingness to pay.
* Experience with diabetes or similar devices and perceived self-benefit significantly affect the responses.

# Introduction

Diabetic foot ulceration (DFU) is a common and serious complication among diabetic patients with an annual incidence of 1-4% and a lifetime risk of 15-25% [[1-3](#_ENREF_1)]. Because it is usually diagnosed late and difficult to heal, DFU may become chronic and substantially increases the risk of becoming infected [[4](#_ENREF_4)]. In situations where a DFU becomes infected, limb amputations may result, causing significant morbidity and psychological stress, negatively affecting patient’s quality of life [[5](#_ENREF_5), [6](#_ENREF_6)]. So early identification of DFU and prevention of ulcer complications is of great importance and would lead to effective DFU management.

It is acknowledged that there is a relationship between plantar tissue pressure and ulceration [[7-9](#_ENREF_7)], and therapeutic footwear and custom insoles have been developed and demonstrated reduction in DFU recurrence rates [[10](#_ENREF_10)], but these are passive strategies and it is not easy for patients to self-control their foot pressure. On the other hand, a recent systematic review concluded that the increase in skin temperature would be predictive of foot ulceration [[11](#_ENREF_11)], so temperature monitoring may be an effective way to predict and prevent DFU occurrence. Taking these factors into account, a medical device could be developed in the form of a shoe insert to monitor the feet of people with diabetes, as well as reduce their plantar pressure, in order to enable early detection and active prevention of foot ulceration. A prototype active shoe insert has been developed, which utilises discrete temperature sensors located at 8 plantar sites most susceptible to DFU and can operate for 10 hours [[12](#_ENREF_12)]. A novel version is under development and the new system will have up to 60 discrete temperature sensors embedded in a 3-4mm thick insole which will interface with a miniature hub housing electronics and wireless connection to a smart watch to provide biofeedback to the user. The costs of this shoe insert were estimated at £150.

As a similar device for diabetes care is not available in practice yet, valuation of this shoe insert is needed to understand the perceptions and attitudes of consumers. Willingness to pay (WTP) is a widely used approach to valuing services not available in traditional markets by constructing a hypothetical but realistic scenario and measures the consumers’ maximum WTP if the services existed [[13](#_ENREF_13), [14](#_ENREF_14)]. In countries that provide universal health care system, e.g., the UK, the health care budget comes from a combination of compulsory insurance and tax revenues, so general public’s willingness to pay for a specific service should be investigated and considered. One widely used method is the contingent valuation method (CVM), which utilises open-ended questions to ask respondents to state their maximum willingness to pay for the service. CVM has been increasingly used in WTP studies on different aspects of health and health care [[14-19](#_ENREF_14)], but to the best of our knowledge, this method has not been used in studies valuing medical devices yet. Moreover, medical technology is a new and developing field with numerous pilot implementations, all in an attempt to achieve increased access to healthcare and technology [[20](#_ENREF_20)]. Understanding consumers’ willingness to pay would provide evidence for preferences of the public, explore the potential feasibility for health funders to fund it, enable further cost-effectiveness assessment and contribute to development of the business model that can be used for scaled-up implementation in clinical practice.

Therefore, in this study, we aimed to investigate the WTP for this new medical device among the general public in the UK and assess the impact of socio-demographic and health-related determinants on individuals’ WTP.

# Methods

## Data

Participants were recruited using Research Now, an online market research company, in December 2016. This research company has access to a panel of over 600,000 UK residents, who have opted in to be part of the panel through “by-invitation only” method. Only the pre-validated individuals would be invited and they have the option to unsubscribe at any time. Panellists are rewarded for taking part in surveys which is normally via “points” and once they reach a certain number of points, a voucher would be sent to them. In this study, only adults (aged 18 or above) were eligible. Data were collected through an online survey using a structured questionnaire (see Appendix 1 for full questionnaire). To ensure the data quality, the fieldwork was conducted first to test the questionnaire and gain initial feedback. After checking the interim data, the full survey was launched to achieve the target sample size. Past experience of the online research shows that respondents who complete the survey too quickly (less than 30%-50% of median time) are likely not reading or answering the questions appropriately [[21](#_ENREF_21)], and therefore, in this study, we removed responses from the “speeders”, whose completion time was less than 30% of the median length of the survey identified across the entire sample. Finally, a total of 1051 subjects were recruited.

In the survey, socio-demographic characteristics (age, gender, ethnicity, marital status, educational level, employment status, religion and annual household income) were first documented. Second, the respondent’s self-reported health was measured by a 5-point scale (excellent, good, average, poor, and very poor) and the number of doctor visits in the past 12 months was recorded as 4 categories (never, once, 2-5 times, and 6 times or more). Third, respondents were asked whether they or their close family had personal, first-hand experience of diabetes and then how they perceived their own risk of ever getting diabetes using a 3-point scale (more than average, average, and less than average). Fourth, their experience with similar medical devices was asked as follows: “Have you or anyone in your close family ever had personal, first-hand experience of using a diabetes medical device, e.g., blood glucose meters, insulin pumps, continuous glucose monitors? Yes/No/Don’t know” and their self-perceived likelihood of needing to use such devices in the future was asked using the question “How would you describe your likelihood of needing to use diabetes medical devices?” and rated using the 3-point scale (more than average, average, and less than average).

Then, all participants were presented with the detailed information on this shoe insert and a picture of a prototype, shown in Figure 1. Last, questions about their WTP for this device were asked. Respondents were first asked if they would be willing to contribute in the form of extra tax and then if they would be willing to make a voluntary donation for the use of this device among diabetic patients. If people answered yes to either contribution question, they were asked to choose one from the annual WTP value categories (under £150, £150 to under £200, £200 to under £250, and £250 or more) and then to give an exact number of the amount they would like to contribute. The WTP value categories were determined based on the estimated costs of this device and £50 increment per category. After the WTP questions, respondents were asked for the reasons why they were willing to contribute. If individuals didn’t answer ‘Yes’ to any of the two contribution questions, they were asked follow-up questions to identify the reasons for not willing to contribute.

## Statistical analysis

Characteristics of the participants were described using mean and standard deviation (SD) for continuous variables and frequency and percentage for categorical variables. For individuals who didn’t answer ‘Yes’ to any of the two contribution questions, the WTP values were recorded as 0 and then WTP responses were transformed into two categories, positive-WTP versus zero-WTP. Among those who were willing to pay, the mean (SD) and median (interquartile range [IQR]) values of annual WTP were calculated.

Chi-square tests were used to assess the significance of WTP responses (positive-WTP/zero-WTP) and the factors collected. As there was an important proportion of the whole sample (44.1%) reporting zero-WTP, special attention should be paid to handing these zero values. In this study, we used the two-part model, which has been widely used in statistics and econometrics literature [[22-25](#_ENREF_22)] and has been shown to have some desirable features in addressing the ceiling/floor effect of data [[26](#_ENREF_26)]. The first part of the two-part model was a logistic regression for the probability of achieving the positive WTP values on the entire sample. The coefficient of the reference group was set to be 0 or the odds ratio (OR) was 1. A positive coefficient (or OR>1) suggests that variable increases the likelihood of willingness to contribute, while a negative coefficient (or OR<1) suggests that the variable decreases the likelihood. The second part was a generalised linear regression of the log-transformed WTP values for respondents whose WTP value was positive. Log transformation of WTP values was used because of its positively skewed distribution. The exponentiated coefficient was the estimated OR, corresponding to changes in the ratio of the expected WTP values conditional on having positive WTP values in the second part. Additionally, Tobit model has been shown to perform better than linear regression models when there are substantial part of the sample with zero values [[27](#_ENREF_27)] and used widely in many willingness to pay studies [[16](#_ENREF_16), [27-30](#_ENREF_27)], so we also used Tobit model as supplementary analysis. The Tobit coefficients do not directly give the marginal effects of the associated independent variables on the dependent variable, but show the direction of change in probability of WTP and the intensity of maximum WTP as the respective explanatory variable changes [[31](#_ENREF_31)].

In the analysis of determinants of WTP, age was coded into categorical variables (young [≤45 years]/middle-aged [45-65 years]/old [>65 years]) and self-reported health was re-coded into 4 groups (excellent/good/average/poor or very poor) due to the very few observations in category “very poor” (1.05%). All factor variables included in this analysis are described in Table 2. Data analyses were performed using STATA 14.0 (Stata Corporation, College Station, Texas, USA). A *p*-value of <0.05 was considered statistically significant.

# Results

## Stated WTP values

Table 1 summarises the willingness to pay results. Among the 1051 respondents, 429 (40.8%) were willing to contribute in the form of extra tax and 497 (47.3%) were willing to make a voluntary donation (Table 1). In total, 588 (55.9%) respondents expressed a positive WTP value and 463 (44.1%) expressed zero WTP. 478 (81.3%) of those willing to contribute preferred to pay less than £150. The mean (SD) and median (IQR) WTP amount was £76.9 (69.1) and £50 (80), respectively. The most two important reasons for WTP was *I/household member might benefit* and *the programme will improve health;* the most frequent reason for not contributing was *the users should pay*.

## Sample characteristics

Table 2 shows the respondents’ characteristics. The mean age was 45.9 (SD: 16.6) years; 536 (51%) were females; 926 (88.1%) were Caucasians; 661 (62.9%) were married or living with partner. 320 (30.4%) had a Bachelor’s degree or higher; 691 (65.7%) were employed or self-employed. 56.5% of the respondents had an annual household income less than £32,000. 71.6% rated their own health as good or excellent and 57.3% respondents visited a doctor only once or none in the past 12 months. With regard to knowledge and risk perception of diabetes and medical devices, 58.4% had first-hand diabetes experience and 77.0% considered themselves to have average or more risk of developing diabetes. 42.8% respondents or their family have used a diabetes medical device and 70.4% considered themselves to have average or more likelihood of needing to use such devices.

Table 2 also shows the respondents’ characteristics by WTP responses. Respondents with positive WTP were younger than those with zero WTP (44.9 vs. 47.1 years) and there were more males, with higher level education, and employed/self-employed in the positive WTP group. There was no significant difference in self-reported health between two groups but there were more individuals who visited doctors once among those with positive WTP while more individuals who never visited a doctor in the zero WTP group. Regarding the experience and self-perceived risk of diabetes and medical devices, there were more respondents having diabetes experience, considering themselves to have more than average risk of developing diabetes, having used similar devices, and considering themselves to have more than average likelihood of needing to use similar devices among the respondents willing to pay than those not willing to contribute.

## Determinants of WTP values

Table 3 presents the results from the two-part model. In the 1st part logistic regression, the following factors were associated with higher likelihood of willingness to pay: old age, middle-level education, good or excellent self-reported health, visiting doctors once or 2-5 times, diabetes experience, medical device experience, and more than the average self-perceived likelihood of using similar devices, compared to the corresponding reference levels, i.e., young age, low education, poor/very poor self-reported health, never visit doctors, no first-hand diabetes experience, no experience of such device/don’t know, less than the average self-perceived likelihood of needing to use such device. In the 2nd part of the model, there was an 18.2% decrease in WTP values for the middle-aged respondents than for the young ones. Female had 18.9% lower WTP values than males. Compared to respondents with annual household income <£19,000, the WTP values are 35.3% higher for those with annual household income ≥£64,000. Tobit shows that the following factors were significantly associated with higher probability of WTP and higher WTP values: male, middle-education, excellent self-report health, visiting doctors once or 2-5 times, diabetes experience, medical device experience, and more than the average self-perceived likelihood of using similar devices, similar to the results using 2-part model (see Appendix 2 for details).

# Discussion

By presenting people with this newly developed medical device and asking them to value it if the device was available in the market, more than half of the respondents showed willingness and the mean annual WTP was £76.9, indicating this new device was considered worthwhile by respondents and they did value it highly. Since there is no similar device available in the market, the high willingness to pay suggests that there is a strong need for similar medical devices and thus more research should be undertaken in this field.

Some socio-demographic factors, such as age, gender, education and income level, were significantly associated with WTP. Compared to the young (aged 45 years or less), the old (aged 65 years above) were more willing to pay for this diabetic device, but not the case with the middle-aged (aged 45-65 years) respondents. The association of older age and increased preference has been observed before [[16](#_ENREF_16)]. This is in agreement with the idea that high self-perceived benefit from this device could be a strong reason for willingness to pay; the benefit would be higher for old respondents than for the middle-aged or young ones. Among those willing to contribute, the WTP values significantly decreased with age. One possible explanation may be that old respondents are less well-off than their younger counterparts [[14](#_ENREF_14)], and thus they couldn’t afford a high WTP value although they would like to contribute. Similar to many previous studies [[32-35](#_ENREF_32)], we found gender-related differences in WTP values. This gender effect may be explained by the different roles and responsibilities of males and females that are socially determined [[35](#_ENREF_35)]. Women are usually located primary responsibility for household and domestic labour while men are much more closely identified with public world, including activities of waged work [[36](#_ENREF_36)]. Due to these social and economic differences, it is possible when assessing the value of a health service in monetary terms, the female respondents tended to give a lower WTP value than the male. Education was also a determinant of WTP responses. Respondents with better education were more likely to make a contribution. This finding may result from better educated people being able to better understand the value of this device [[32](#_ENREF_32)], and therefore they would be more likely to accept it. Probably due to the secondary effect of income, a higher education was not found to be associated with higher WTP values, contradicted to most studies [[17](#_ENREF_17), [32](#_ENREF_32), [33](#_ENREF_33), [35](#_ENREF_35)]. Respondents with higher income had higher WTP values, which appeared to be natural as higher income levels enable respondents to spend more money on some services they value. Income has often been reported to be a proxy indicator of ability-to-pay in previous WTP studies [[14](#_ENREF_14), [37-39](#_ENREF_37)].

The health-related variables, prior experience of diabetes or similar medical device experience, and self-perceived likelihood of needing to use similar devices were significantly associated with probability of willingness to pay, but not with the WTP values. Respondents with better self-reported health were more likely to contribute than those reporting their health as poor/very poor and compared to those who never visited a doctor in the past 12 months, participants who have visited their doctors were significantly more willing to pay. The self-reported health and number of doctor visits variables could partially reflect the level of care about health. Those with excellent self-reported health may be more likely to be incentivised to promote this new medical device to help diabetic patients live better, supported by the two reasons for contributing, ‘*I/household member might benefit*’ and ‘*other people will benefit*’. Regarding the number of doctor visits, these who have never visited a doctor may care less about their health, so they would be less interested in the development of a new healthcare technology and consequently, they were less likely to make a contribution for the device in this study. With the prior knowledge about the disease and in recognition of the value of this device by using similar ones, the respondents were more willing to contribute to it. If personal benefit was perceived, the probability of willingness to pay also increased. As there was no example for the medical device investigated in this study and majority of respondents had no experience of similar devices, it is more likely that they would revert to personal need as the main determinant of WTP.

This study is among the first to use WTP methodology to explore public preference with respect to medical devices in diabetes care. The findings would help the providers of this device and other similar services, and potential funders to develop an understanding of the potential market. Results clearly demonstrates that the person characteristics would affect the willingness to pay, but the more important determinants are how general public rate and care about their own health and the “value” derived from the device, based on their experience with diabetes and similar devices, and their expectation of using it in future life. Such results might have important implications for the device providers that a more active role could be adopted to promote the public’s understanding of the effectiveness of the device. Additionally, the results would provide an important component to the economic business model of this device for marketing application. For example, determinants identified here could be used to define the target consumers if this device is aimed to be covered by insurance.

In this study, WTP data were analysed using the two-part model, one of the preferred approaches in handing data with ceiling/floor effect [[40](#_ENREF_40)], which would provide better estimates of the respondents’ preference, as well as identify significant determinants of both probability of willingness to pay and the WTP values. There are some minor limitations to this study. The open-ended question format of the WTP value may introduce bias because respondents tend to give a number towards the median [[41](#_ENREF_41)], although the WTP value categories and open-ended question about the exact WTP value were used to reduce such bias. Moreover, participants were recruited from an online survey, which may be biased to the well-educated and young respondents as the Internet would be more accessible to them. Therefore, interpretation of the results should take into account the limitations.

# Conclusions

For a newly developed medical device which would enable early detection and active prevention of foot ulceration among diabetic patients, the general public considered it worthwhile and some socio-demographic characteristics, their experience with diabetes or similar medical devices and self-perceived benefit from it were important determinants on their WTP. Given the high preference and lack of such devices in markets, this study provides vital information on public preference and how they would vote for allocation of resources to this device.

**Author Contributions**: FY designed the questionnaire, led the data analysis and interpretation and was primarily responsible for drafting the manuscript. BG and AW supported data interpretation and commented on and amended the draft manuscript.

**Compliance with Ethical Standards**

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**Conflict of Interest:** Fan Yang, Brenda Gannon,Andrew Weightman have no conflict of interest to declare.

**Data availability:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

**Table 1.** Willingness to pay (WTP) responses for this medical device†

|  |  |
| --- | --- |
|  | Total, n=1051 |
| In the form of extra tax |  |
| Yes | 429 (40.8) |
| No | 258 (24.6) |
| No one pays income tax | 68 (6.6) |
| Don’t know | 296 (28.2) |
| In the form of voluntary donation |  |
| Yes | 497 (47.3) |
| No | 294 (28.0) |
| Don’t know | 260 (24.7) |
| WTP response |  |
| Positive WTP | 588 (55.9) |
| Zero WTP | 463 (44.1) |
| WTP category (n=588) |  |
| Under £150 | 478 (81.3) |
| £150 to under £200 | 70 (11.9) |
| £200 to under £250 | 27 (4.6) |
| More than £250 | 13 (2.2) |
| WTP value (£) (n=588) |  |
| Mean (SD) | 76.9 (69.1) |
| Median (IQR) | 50 (80) |
| Top three reasons for willing to contribute |  |
| *I, or a member of my household, might benefit.* | 436 (74) |
| *The programme will improve health.* | 355 (60) |
| *Other people will benefit.* | 354 (60) |
| Most important reason for not willing to contribute |  |
| *The users should pay.* | 115 (25) |
| *I can't afford it.* | 91 (20) |
| *Health service should be more efficient.* | 75 (16) |
| †The values are n (%) unless otherwise specified.  IQR: interquartile range, SD: standard deviation |  |

**Table 2.** Characteristics of all respondents and by different willingness to pay (WTP) responses†

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Total (n=1051) | Positive-WTP (n=588) | Zero-WTP (n=463) | *p*-value |
| Age (years), mean (SD) | 45.9 (16.6) | 44.9 (16.8) | 47.1 (16.3) | 0.035 |
| Young (≤45 years) | 538 (51.2) | 322 (54.8) | 216 (46.6) | 0.013 |
| Middle-aged (45-65 years) | 334 (31.8) | 166 (28.2) | 168 (36.3) |  |
| Old (>65 years) | 179 (17.0) | 100 (17.0) | 79 (17.1) |  |
| Gender |  |  |  | 0.036 |
| Male | 515 (49.0) | 305 (51.9) | 210 (45.4) |  |
| Female | 536 (51.0) | 283 (48.1) | 253 (54.6) |  |
| Ethnicity |  |  |  | 0.244 |
| Caucasian | 926 (88.1) | 512 (87.1) | 414 (89.4) |  |
| Non-Caucasian | 125 (11.9) | 76 (12.9) | 49 (10.6) |  |
| Marital status |  |  |  | 0.878 |
| Non-married and not living with partner | 390 (37.1) | 217 (36.9) | 173 (37.4) |  |
| Married/living with partner | 661 (62.9) | 371 (63.1) | 290 (62.6) |  |
| Educational level |  |  |  | <0.001 |
| Low (O level or below) | 354 (33.7) | 169 (28.7) | 185 (40.0) |  |
| Middle (A level or diploma) | 377 (35.9) | 233 (39.6) | 144 (31.1) |  |
| High (Bachelor’s degree or above) | 320 (30.4) | 186 (31.6) | 134 (28.9) |  |
| Employment status |  |  |  | 0.040 |
| Unemployed | 168 (16.0) | 85 (14.5) | 83 (17.9) |  |
| Employed/self-employed | 691 (65.7) | 406 (69.0) | 285 (61.6) |  |
| Retired | 192 (18.3) | 97 (16.5) | 95 (20.5) |  |
| Religion |  |  |  | 0.434 |
| Christian | 550 (52.3) | 314 (53.4) | 236 (51.0) |  |
| Non- Christian | 501 (47.7) | 274 (46.6) | 227 (49.0) |  |
| Annual household income |  |  |  | 0.949 |
| Under £19,000 | 288 (27.4) | 158 (26.9) | 130 (28.1) |  |
| £19,000 to under £32,000 | 306 (29.1) | 174 (29.6) | 132 (28.5) |  |
| £32,000 to under £64,000 | 322 (30.6) | 182 (30.9) | 140 (30.2) |  |
| £64,000 or more | 135 (12.8) | 74 (12.6) | 61 (13.2) |  |
| Self-reported health |  |  |  | 0.132 |
| Poor/very poor | 79 (7.5) | 40 (6.8) | 39 (8.4) |  |
| Average | 220 (20.9) | 114 (19.4) | 106 (22.9) |  |
| Good | 578 (55.0) | 325 (55.3) | 253 (54.6) |  |
| Excellent | 174 (16.6) | 109 (18.5) | 65 (14.0) |  |
| Number of doctor visits |  |  |  | 0.004 |
| Never | 337 (32.1) | 164 (27.9) | 173 (37.4) |  |
| Once | 265 (25.2) | 168 (28.6) | 97 (20.9) |  |
| 2-5 times | 359 (34.2) | 205 (34.9) | 154 (33.3) |  |
| 6 times or more | 90 (8.6) | 51 (8.7) | 39 (8.4) |  |
| Diabetes experience |  |  |  | <0.001 |
| No | 437 (41.6) | 177 (30.1) | 260 (56.2) |  |
| Yes | 614 (58.4) | 411 (69.9) | 203 (43.8) |  |
| Self-perceived risk of diabetes |  |  |  | <0.001 |
| Less than average | 242 (23.0) | 105 (17.9) | 137 (29.6) |  |
| Average | 422 (40.2) | 206 (35.0) | 216 (46.6) |  |
| More than average | 387 (36.8) | 277 (47.1) | 110 (23.8) |  |
| Medical device experience |  |  |  | <0.001 |
| No or don’t know | 601 (57.2) | 264 (44.9) | 337 (72.8) |  |
| Yes | 450 (42.8) | 324 (55.1) | 126 (27.2) |  |
| Self-perceived likelihood of using similar devices | | |  | <0.001 |
| Less than average | 311 (29.6) | 135 (23.0) | 176 (38.0) |  |
| Average | 458 (43.6) | 234 (39.8) | 224 (48.4) |  |
| More than average | 282 (26.8) | 219 (37.2) | 63 (13.6) |  |
| †The values are n (%) unless otherwise specified. | | |  |  |

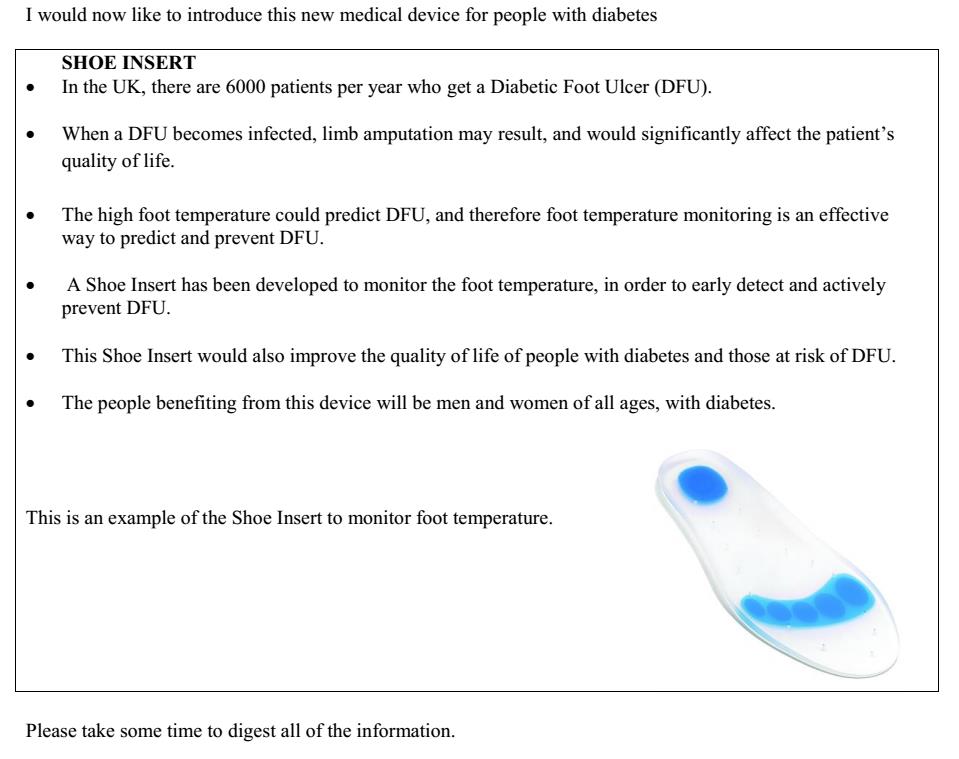
**Table 3.** Two-part model for the willingness to pay (WTP) responses.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Variables** | 1st part: logistic regression model for the probability of reporting positive WTP values | | |  | 2nd part: generalised linear regression for log-transformed WTP values for those with positive values | | |
| **Coefficient** | **Standard Error** | **Odds ratio** |  | **Coefficient** | **Standard Error** | **Odds ratio** |
| Middle-aged | -0.102 | 0.167 | 0.903 |  | -0.201\* | 0.087 | 0.818 |
| Old | 0.626\* | 0.296 | 1.869 |  | -0.361 | 0.193 | 0.697 |
| Female | -0.268 | 0.143 | 0.765 |  | -0.209\*\* | 0.071 | 0.811 |
| Non-Caucasian | 0.149 | 0.224 | 1.161 |  | 0.041 | 0.101 | 1.042 |
| Married/living with partner | -0.204 | 0.153 | 0.815 |  | -0.025 | 0.071 | 0.975 |
| Middle education | 0.466\*\* | 0.170 | 1.593 |  | 0.125 | 0.091 | 1.133 |
| High education | 0.273 | 0.190 | 1.313 |  | -0.127 | 0.106 | 0.881 |
| Retired | -0.425 | 0.313 | 0.654 |  | -0.079 | 0.222 | 0.924 |
| Employed/self-employed | 0.145 | 0.208 | 1.156 |  | 0.125 | 0.119 | 1.133 |
| Non-Christian | -0.142 | 0.142 | 0.867 |  | -0.075 | 0.070 | 0.927 |
| Annual household income (£19,000 to under £32,000) | 0.016 | 0.193 | 1.016 |  | 0.102 | 0.097 | 1.107 |
| Annual household income (£32,000 to under £64,000) | -0.059 | 0.208 | 0.943 |  | 0.157 | 0.099 | 1.170 |
| Annual household income (£64,000 or more) | -0.217 | 0.267 | 0.805 |  | 0.303\* | 0.120 | 1.353 |
| Self-reported health (average) | 0.282 | 0.295 | 1.326 |  | -0.245 | 0.172 | 0.783 |
| Self-reported health (good) | 0.579\* | 0.281 | 1.784 |  | -0.141 | 0.158 | 0.868 |
| Self-reported health (excellent) | 0.832\* | 0.326 | 2.298 |  | 0.027 | 0.170 | 1.028 |
| Visit doctors once | 0.498\*\* | 0.184 | 1.645 |  | 0.168 | 0.089 | 1.182 |
| Visit doctors 2-5 times | 0.333\* | 0.169 | 1.395 |  | 0.101 | 0.090 | 1.106 |
| Visit doctors 6 times or more | 0.453 | 0.281 | 1.573 |  | 0.036 | 0.156 | 1.037 |
| Having first-hand diabetes experience | 0.386\* | 0.175 | 1.471 |  | 0.101 | 0.107 | 1.107 |
| Self-perceived risk of diabetes (average) | 0.157 | 0.241 | 1.170 |  | 0.073 | 0.159 | 1.076 |
| Self-perceived risk of diabetes (more than average) | 0.422 | 0.289 | 1.525 |  | 0.029 | 0.179 | 1.029 |
| Having used similar diabetes device | 0.696\*\*\* | 0.176 | 2.005 |  | 0.078 | 0.089 | 1.081 |
| Self-perceived likelihood of using similar devices (average) | 0.094 | 0.226 | 1.098 |  | -0.006 | 0.155 | 0.994 |
| Self-perceived likelihood of using similar devices (more than average) | 0.688\* | 0.296 | 1.990 |  | 0.358 | 0.187 | 1.430 |

Reference categories used in regression are young (≤45), male, Caucasian, non-married and not living with partner, low education, unemployed, Christian , annual household income (< £19,000), poor/very poor self-reported health, never visit doctors, without first-hand diabetes experience, less than average self-perceived risk of diabetes, without experience of such devices/don’t know, less than average self-perceived likelihood of using similar devices.

The level designated as the reference has coefficient set to be 0, and odds ratio set to be 1.

\**p*<0.05; \*\**p*<0.01; \*\*\**p*<0.001



**Figure 1**. Information about this medical device in questionnaire

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**Supplementary material 1.** Questionnaire

A research team from the University of Manchester is collecting information on your views on a medical device for patients with diabetes.

The objective of this study is to establish the degree of importance people put on a new medical device developed for diabetic patients and determine how to fund this device.

We would like to know how much YOU would, hypothetically, be willing to pay for this new medical device. There is, of course, no question of anyone actually having to pay for it. All we want to know is how much YOU would be willing to pay for it.

This survey will take about 15 minutes to complete. All the information collected will be treated in the strictest confidence. There are no right or wrong answers. The amount you are willing to pay could be large or small, or it could be nothing. It is your views and your opinions that we are interested in.

First, I would like to ask you a few questions about yourself and your household.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. | **What is your date of birth?** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | \_\_\_\_\_\_\_\_(day) \_\_\_\_\_\_\_\_ (month) \_\_\_\_\_\_\_\_ (year) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. | **Sex** | Male ❑ | | | | | Female ❑ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  |  |  | | | | | | | | | |  | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. | **What is your ethnicity?** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | White | | | | | | | | | ❑ | | | | Prefer not to say | | | | | | ❑ | | | | | | | | | | | | | | | | |
|  | Any other ethnic group | | | | | | | | | ❑ | | | |  | | | | | | | | | | | | | | | | | | | | | | |
|  |  | |  | | | | | | | | | | |  | | | | | | | | | | | | | | | | | | | | | | |
| 3. | **What is your marital status:** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | Single | | | | | | | | | ❑ | | Widowed | | | | | | | | | | | ❑ | | | | | | | | | | | | | |
|  | Married or living with partner | | | | | | | | | ❑ | | Prefer not to say | | | | | | | | | | | ❑ | | | | | | | | | | | | | |
|  | Divorced/separated | | | | | | | | | ❑ | |  | | | | | | | | | | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4. | **What is the highest education or school qualification you have attained?** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | Bachelor’s degree or higher | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ❑ | | |  |  | | |
|  | Higher national diploma or higher national certificate | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ❑ | | |  |  | | |
|  | A Level | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ❑ | | |  |  | | |
|  | GCSE/O Level | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ❑ | | |  |  | | |
|  | Other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ❑ | | |  |  | | |
|  |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | |
| 5. | **What is your employment status?** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | |
|  | Employed or self-employed | | | | | | | | | ❑ | | | | Looking after family or home | | | | | | | | | | | | | | ❑ | | | | | | | | |
|  | Retired | | | | | | | | | ❑ | | | | Long-term sick or disabled | | | | | | | | | | | | | | ❑ | | | | | | | | |
|  | Student | | | | | | | | | ❑ | | | | Other / none of the above | | | | | | | | | | | | | | ❑ | | | | | | | | |
|  |  | | | | | | | | |  | | | |  | | | | | | | | | | | | | | | | | | | | | | |
| 6. | **What is your religion?** | | | | | | | | |  | | | |  | | | | | | | | | | | | | | | | | | | | | | |
|  | Christian | | | | | | | | | ❑ | | | | No religion | | | | | | | | ❑ | | | | | | | | | | | | | | |
|  | Any other religion | | | | | | | | | ❑ | | | | Prefer not to say | | | | | | | | ❑ | | | | | | | | | | | | | | |
|  |  | | | | | | | | |  | | | |  | | | | | | | | | | | | | | | | | | | | | | |
| 7. | **Could I ask you about the approximate level of net household income?**  *A* ***household*** *consists of one or more people who live in the same dwelling and share at meals or living accommodation, e.g. you and your partner.*  *The* ***net household income*** *means the total income, after tax and other statutory deductions, of all members of the household. It includes all types of income: income from employment, social welfare payments, rents, interest, pensions, etc. We would just like to know which broad group the total income of your household falls into. The groups are shown below. All information is entirely confidential.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | **Annual household income** | | | | | | | | | | | | | | | |  | **Category** | | | | | | | | | | | | | | | | | | |
|  | Under £6,000 | | | | | | | | | | | | | | | |  | A | | | | | | | ❑ | | | | | | | | | | | |
|  | £6,000 to under £13,000 | | | | | | | | | | | | | | | |  | B | | | | | | | ❑ | | | | | | | | | | | |
|  | £13,000 to under £19,000 | | | | | | | | | | | | | | | |  | C | | | | | | | ❑ | | | | | | | | | | | |
|  | £19,000 to under £26,000 | | | | | | | | | | | | | | | |  | D | | | | | | | ❑ | | | | | | | | | | | |
|  | £26,000 to under £32,000 | | | | | | | | | | | | | | | |  | E | | | | | | | ❑ | | | | | | | | | | | |
|  | £32,000 to under £48,000 | | | | | | | | | | | | | | | |  | F | | | | | | | ❑ | | | | | | | | | | | |
|  | £48,000 to under £64,000 | | | | | | | | | | | | | | | |  | G | | | | | | | ❑ | | | | | | | | | | | |
|  | £64,000 to under £96,000 | | | | | | | | | | | | | | | |  | H | | | | | | | ❑ | | | | | | | | | | | |
|  | £96,000 or more | | | | | | | | | | | | | | | |  | I | | | | | | | ❑ | | | | | | | | | | | |
|  |  | | | | | | | | Refused | | | | | | | |  |  | | | | | | | ❑ | | | | | | | | | | | |
|  |  | | | | | | | | Don’t know | | | | | | | |  |  | | | | | | | ❑ | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8. | **Taking your age into account, how would you describe your health?** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | Excellent | | | Good | | | | | | | Average | | | | Poor | | | | Very poor | | | | | | | | | | | | | | | | | |
|  | ❑ | | | ❑ | | | | | | | ❑ | | | | ❑ | | | | ❑ | | | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9. | **In the last 12 months, how many times have you consulted, or been visited at home, by a doctor?** *Please do not include visits on behalf of someone else such as a child.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | Never | | | | | | | Once | | | | | | | | | 2-5 times | | | | | | | | | 6 times or more | | | | | | | | | | |
|  | ❑ | | | | | | | ❑ | | | | | | | | | ❑ | | | | | | | | | ❑ | | | | | | | | | | |
|  |  | | | | | | |  | | | | | | | | |  | | | | | | | | |  | | | | | | | | | | |
| 10. | **Have you or anyone in your close family ever had personal, first-hand experience of diabetes:** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | Yes | | | | | No | | | | | | | | | | | | | | | | | | | | |  | | | |
|  | ❑ | | | | | ❑ | | | | | | | | | | | | | | | | | | | | |  | | | |
|  |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | |
| 11. | **How do you perceive your own risk of ever getting diabetes? Is it:** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | |
|  | More than average | | | | Average | | | | | | | | Less than average | | | | | | | | | | | | | | | |  | | |  | | | |
|  | ❑ | | | | ❑ | | | | | | | | ❑ | | | | | | | |  | | |  | | | | | | | |  | | | |
|  |  | | | |  | | | | | | | |  | | | | | | | |  | | |  | | | | | | | |  | | | |
| 12. | **Have you or anyone in your close family ever had personal, first-hand experience of using a diabetes medical device, e.g., blood glucose meters, insulin pumps, continuous glucose monitors:** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | Yes | | | | | No | | | | | | | | | | Don’t know | | | | | | | | | | |  | | | |
|  | ❑ | | | | | ❑ | | | | | | | | | | ❑ | | | | | | | | | | |  | | | |
|  |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | |
| 13. | **Using the scale below, how would you describe your likelihood of needing to use diabetes medical devices?** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | |
|  | More than average | | | | Average | | | | | | | | Less than average | | | | | | | |  | | |  | | | | |  | | |  | | | |
|  | ❑ | | | | ❑ | | | | | | | | ❑ | | | | | | | |  | | |  | | | | | | | |  | | | |

I would now like to introduce this new medical device for people with diabetes

|  |
| --- |
| **SHOE INSERT**   * In the UK, there are 6000 patients per year who get a Diabetic Foot Ulcer (DFU). * When a DFU becomes infected, limb amputation may result, and significantly affect the patient’s quality of life. * A shoe insert has been developed that could detect and actively prevent DFU. * This Shoe Insert would improve the quality of life of people with diabetes and those at risk of DFU. * The people benefiting from this device will be men and women of all ages, with diabetes. |

Please take some time to digest all of the information.

Now, I’m now going to ask you about how much you value this device.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. | **Would your household be willing to contribute anything in extra income tax for the use of this device among diabetic patients?** | | | | | | | | | | | | | | | |
|  | Yes | | No | | | Don’t know | | No one in the household pays income tax | | | | | | | |
|  | ❑ | | ❑ | | | ❑ | | ❑ | | | |  | | | |
|  | *(If you don’t pay tax but someone in your household does, tick box number 3 for Don’t Know and go to the next question)* | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | |
| 2. | **If the payment was in terms of a voluntary donation, would your household be willing to pay for the use of this device among diabetic patients?** | | | | | | | | | | | | | | | |
|  | Yes | | No | | | Don’t know |  | |  | | | |  | | |
|  | ❑ | | ❑ | | | ❑ |  | |  | | | |  | | |
|  | *(If you answered Yes to either 1. or 2. go to 3. If you did not answer Yes to either one, go to 5.)* | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | |
| 3. | **How much is the MAXIMUM your household would be willing to contribute each year for the use of this device among diabetic patients? Please bear in mind that your contribution would reduce what you have left to spend on other things.** | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | |
|  | **AMOUNT PER YEAR** | | | | | | | | | | | | | | | |
|  | £0 to under £150 | | | ❑ |  | | | | | | | | | | | |
|  |  | Could you fill in the exact amount you would be willing to pay? £\_\_\_\_\_\_\_\_\_ | | | | | | | | | | | | | | |
|  | £150 to under £200 | | | ❑ |  | | | | | | | | | | | |
|  |  | Could you fill in the exact amount you would be willing to pay? £\_\_\_\_\_\_\_\_\_ | | | | | | | | | | | | | | |
|  | £200 to under £250 | | | ❑ |  | | | | | | | | | | | |
|  |  | Could you fill in the exact amount you would be willing to pay? £\_\_\_\_\_\_\_\_\_ | | | | | | | | | | | | | | |
|  | £250 or more | | | ❑ |  | | | | | | | | | | | |
|  |  | Could you fill in the exact amount you would be willing to pay? £\_\_\_\_\_\_\_\_\_ | | | | | | | | | | | | | | |
|  | Other (please specify) ❑ | | | | | | | | | | | | | | | |
|  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | |
| 4. | **And why would your household be likely to contribute to the use of this device for diabetic patients?  Please indicate all the reasons that apply, as well as the most important reason.** | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | Column A  Important reasons | | | | Column B  Most important reason | | |
|  | I, or a member of my household, might benefit | | | | | | | | | ❑ | | | | ❑ | | |
|  | A member of my family or a friend has used similar service | | | | | | | | | ❑ | | | | ❑ | | |
|  | Other people will benefit | | | | | | | | | ❑ | | | | ❑ | | |
|  | The programme will improve health | | | | | | | | | ❑ | | | | ❑ | | |
|  | Promote more equal access to care | | | | | | | | | ❑ | | | | ❑ | | |
|  | Reassuring to know care is accessible | | | | | | | | | ❑ | | | | ❑ | | |
|  | I would support technical progress in medicine | | | | | | | | | ❑ | | | | ❑ | | |
|  | Other (please specify) | | | | | | | | | ❑ | | | | ❑ | | |
|  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | |  | | | |  | | |
|  |  | | | | | | | | | | | | | | | |
|  | *(only answer 5. if you are not willing to pay for the expansion of the service)* | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | | |
| 5. | **Could you please tell me which one of the listed reasons best explains why you would not be willing to pay for the use of this device?** | | | | | | | | | | | | | | | |
|  | This programme is of no value to my household | | | | | | | | | | ❑ | | | |  | |
|  | Other programmes are more valuable | | | | | | | | | | ❑ | | | |  | |
|  | Other public sector budgets should be cut | | | | | | | | | | ❑ | | | |  | |
|  | Other groups in society should pay | | | | | | | | | | ❑ | | | |  | |
|  | The users should pay | | | | | | | | | | ❑ | | | |  | |
|  | Health service should be more efficient | | | | | | | | | | ❑ | | | |  | |
|  | I can’t afford it | | | | | | | | | | ❑ | | | |  | |
|  | Prefer other ways of paying (private/voluntary insurance, etc.) | | | | | | | | | | ❑ | | | |  | |
|  | Other (please specify) | | | | | | | | | | ❑ | | | |  | |
|  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | | |  | | | |  | |

Thank you very much for your participation!

**Supplementary material 2.** Tobit model estimates of WTP for this medical device.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Coefficient** | **Standard Error** | ***t*-value** |
| Middle-aged | -13.476 | 7.436 | -1.810 |
| Old | 8.804 | 12.937 | 0.680 |
| Female | -20.077\*\* | 6.276 | -3.200 |
| Non-Caucasian | 8.811 | 9.612 | 0.920 |
| Married/living with partner | -11.357 | 6.711 | -1.690 |
| Middle education | 23.152\*\* | 7.558 | 3.060 |
| High education | 1.596 | 8.490 | 0.190 |
| Retired | -16.880 | 14.049 | -1.200 |
| Employed/self-employed | 9.910 | 9.285 | 1.070 |
| Non-Christian | -9.415 | 6.251 | -1.510 |
| Annual household income (£19,000 to under £32,000) | 5.919 | 8.441 | 0.700 |
| Annual household income (£32,000 to under £64,000) | 6.868 | 9.029 | 0.760 |
| Annual household income (£64,000 or more) | 8.422 | 11.620 | 0.720 |
| Self-reported health (average) | 1.589 | 13.419 | 0.120 |
| Self-reported health (good) | 16.329 | 12.770 | 1.280 |
| Self-reported health (excellent) | 38.808\*\* | 14.427 | 2.690 |
| Visit doctors once | 29.152\*\*\* | 8.040 | 3.630 |
| Visit doctors 2-5 times | 18.480\* | 7.567 | 2.440 |
| Visit doctors 6 times or more | 14.274 | 12.456 | 1.150 |
| Having first-hand diabetes experience | 19.410\* | 8.133 | 2.390 |
| Self-perceived risk of diabetes (average) | 10.584 | 11.300 | 0.940 |
| Self-perceived risk of diabetes (more than average) | 18.974 | 13.170 | 1.440 |
| Having used similar diabetes device | 28.131\*\*\* | 7.780 | 3.620 |
| Self-perceived likelihood of using similar devices (average) | 4.605 | 10.562 | 0.440 |
| Self-perceived likelihood of using similar devices (more than average) | 42.846\*\* | 13.048 | 3.280 |
| Reference categories used in regression are young (≤45), male, Caucasian, non-married and not living with partner, low education, unemployed, Christian , annual household income (< £19,000), poor/very poor self-reported health, never visit doctors, without first-hand diabetes experience, less than average self-perceived risk of diabetes, without experience of such devices/don’t know, less than average self-perceived likelihood of using similar devices.  The level designated as the reference has coefficient set to be 0, and odds ratio set to be 1.  \**p*<0.05; \*\**p*<0.01; \*\*\**p*<0.001 | | | |