

Supplementary file 2: Healthcare providers' use and acceptance of translation technologies in multilingual healthcare: A cross-sectional study.

Additional quantitative analyses

- Table S1. Use of communication strategies by professional group

Profession group	Communication strategy	<i>n</i>	N total profession group	%
Psychosocial health professions	Use of a shared language	98	175	56
Psychosocial health professions	Translation apps (e.g. Google Translate)	93	175	53.14
Psychosocial health professions	Service user's family/friends serving as interpreters	51	175	29.14
Psychosocial health professions	Professional interpreters	48	175	27.43
Psychosocial health professions	Use of translated written document	40	175	22.86
Psychosocial health professions	Bilingual staff/colleagues help out as interpreters	37	175	21.14
Psychosocial health professions	Use of visual aids	36	175	20.57
Psychosocial health professions	Service user's underage family/friends serving as interpreters	17	175	9.71
Medical doctors	Translation apps (e.g. Google Translate)	77	109	70.64
Medical doctors	Service user's family/friends serving as interpreters	66	109	60.55
Medical doctors	Use of a shared language	66	109	60.55
Medical doctors	Bilingual staff/colleagues help out as interpreters	54	109	49.54
Medical doctors	Use of translated written document	23	109	21.10
Medical doctors	Service user's underage family/friends serving as interpreters	18	109	16.51
Medical doctors	Professional interpreters	17	109	15.60
Medical doctors	Use of visual aids	13	109	11.93
Nursing staff	Translation apps (e.g. Google Translate)	33	44	75.00
Nursing staff	Service user's family/friends serving as interpreters	32	44	72.73
Nursing staff	Bilingual staff/colleagues help out as interpreters	31	44	70.45
Nursing staff	Use of a shared language	18	44	40.91
Nursing staff	Professional interpreters	13	44	29.55
Nursing staff	Service user's underage family/friends serving as interpreters	9	44	20.45
Nursing staff	Use of visual aids	9	44	20.45
Nursing staff	Use of translated written document	6	44	13.64
Medical-technical and other health professions	Translation apps (e.g. Google Translate)	64	73	87.67

Medical-technical and other health professions	Service user's underage family/friends serving as interpreters	59	73	80.82
Medical-technical and other health professions	Service user's family/friends serving as interpreters	54	73	73.97
Medical-technical and other health professions	Use of a shared language	43	73	58.90
Medical-technical and other health professions	Bilingual staff/colleagues help out as interpreters	32	73	43.84
Medical-technical and other health professions	Use of visual aids	15	73	20.55
Medical-technical and other health professions	Use of translated written document	4	73	5.48
Medical-technical and other health professions	Professional interpreters	2	73	2.74
Therapeutic professions	Translation apps (e.g. Google Translate)	8	21	38.10
Therapeutic professions	Service user's family/friends serving as interpreters	7	21	33.33
Therapeutic professions	Bilingual staff/colleagues help out as interpreters	6	21	28.57
Therapeutic professions	Use of visual aids	5	21	23.81
Therapeutic professions	Use of a shared language	3	21	14.29
Therapeutic professions	Professional interpreters	2	21	9.52
Therapeutic professions	Use of translated written document	1	21	4.76
Administrative staff	Translation apps (e.g. Google Translate)	12	17	70.59
Administrative staff	Use of a shared language	11	17	64.71
Administrative staff	Service user's family/friends serving as interpreters	6	17	35.29
Administrative staff	Bilingual staff/colleagues help out as interpreters	5	17	29.41
Administrative staff	Professional interpreters	5	17	29.41
Administrative staff	Use of visual aids	4	17	23.53
Administrative staff	Use of translated written document	3	17	17.65
Administrative staff	Service user's underage family/friends serving as interpreters	1	17	5.88
Other (free text)	Bilingual staff/colleagues help out as interpreters	1	4	25.00
Other (free text)	Service user's family/friends serving as interpreters	1	4	25.00
Other (free text)	Translation apps (e.g. Google Translate)	1	4	25.00
Other (free text)	Use of a shared language	1	4	25.00
Other (free text)	Use of translated written document	1	4	25.00
Other (free text)	Use of visual aids	1	4	25.00

Multiple responses were possible for strategy; percentages therefore do not sum to 100%. Percentages refer to the proportion of participants selecting each option.

- Table S2. Use of translation technologies by professional group

Profession group	Translation technology	<i>n</i>	<i>N</i> total profession	%
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Psychosocial health professions	Google Translate	129	175	73.71
Psychosocial health professions	DeepL	47	175	26.86
Psychosocial health professions	Online dictionary (e.g. Merriam-Webster, LEO)	30	175	17.14
Psychosocial health professions	No experience with any translation tool	22	175	12.57
Psychosocial health professions	TalkToMe	2	175	1.14
Psychosocial health professions	iTranslate Converse	1	175	0.57
Medical doctors	Google Translate	95	109	87.16
Medical doctors	DeepL	19	109	17.43
Medical doctors	Online dictionary (e.g. Merriam-Webster, LEO)	15	109	13.76
Medical doctors	No experience with any translation tool	7	109	6.42
Medical doctors	Microsoft Translator	3	109	2.75
Medical doctors	iTranslate Converse	3	109	2.75
Medical doctors	Universal Doctor Translator	1	109	0.92
Nursing staff	Google Translate	41	44	93.18
Nursing staff	DeepL	12	44	27.27
Nursing staff	Online dictionary (e.g. Merriam-Webster, LEO)	3	44	6.82
Nursing staff	Microsoft Translator	2	44	4.55
Nursing staff	TalkToMe	2	44	4.55
Nursing staff	No experience with any translation tool	1	44	2.27
Medical-technical and other health professions	Google Translate	70	73	95.89
Medical-technical and other health professions	DeepL	24	73	32.88
Medical-technical and other health professions	Online dictionary (e.g. Merriam-Webster, LEO)	11	73	15.07
Medical-technical and other health professions	Aidminutes	10	73	13.70
Medical-technical and other health professions	Microsoft Translator	3	73	4.11
Medical-technical and other health professions	iTranslate Converse	2	73	2.74
Therapeutic professions	Google Translate	15	21	71.43
Therapeutic professions	No experience with any translation tool	3	21	14.29
Therapeutic professions	Online dictionary (e.g. Merriam-Webster, LEO)	3	21	14.29
Therapeutic professions	DeepL	2	21	9.52
Administrative staff	Google Translate	14	17	82.35
Administrative staff	DeepL	9	17	52.94
Administrative staff	No experience with any translation tool	2	17	11.76
Administrative staff	Online dictionary (e.g. Merriam-Webster, LEO)	1	17	5.88
Other (free text)	DeepL	3	4	75.00

Other (free text)	Google Translate	3	4	75.00
Other (free text)	Online dictionary (e.g. Merriam-Webster, LEO)	3	4	75.00
Other (free text)	Aidminutes	1	4	25.00

Multiple responses were possible for strategy; percentages therefore do not sum to 100%. Percentages refer to the proportion of participants selecting each option.

- Table S3. Modality and functional scope of use by professional group

Profession group	Modality		
	Both functions	Text (written) only	Voice/speech (oral) only
Administrative staff	6 (50.0%)	5 (41.67%)	1 (8.33%)
Nursing staff	23 (63.89%)	12 (33.33%)	1 (2.78%)
Medical-technical and other	58 (81.69%)	9 (12.68%)	4 (5.63%)
Medical doctors	60 (63.16%)	29 (30.53%)	6 (6.32%)
Psychosocial health professionals	59 (46.46%)	65 (51.18%)	3 (2.36%)
Other (free text)	2 (66.67%)	1 (33.33%)	0

Profession group	Functional scope		
	Entire conversations	Full sentences	Specialised single terms
Administrative staff	4 (23.53%)	10 (58.82%)	4 (23.53%)
Medical doctors	35 (32.11%)	69 (63.3%)	37 (33.94%)
Medical-technical and other health professions	40 (54.79%)	63 (86.3%)	36 (49.32%)
Nursing staff	14 (31.82%)	30 (68.18%)	18 (40.91%)
Other (free text)	1 (25.0%)	3 (75.0%)	2 (50.0%)
Psychosocial health professions	20 (11.43%)	90 (51.43%)	83 (47.43%)
Therapeutic professions	4 (19.05%)	6 (28.57%)	6 (28.57%)

Modality proportions are calculated based on the sub-sample of participants who actively use tools and provided a modality preference. Multiple responses were possible for functional scope; percentages therefore do not sum to 100%.

- Table S4. Correlation matrix (TAM + contextual variables)

variable	PEOU	PU	ATT	BI	Encouragement	Conditional Access	Accuracy Concern	Privacy Concern
Perceived ease of use (PEOU)	1.0	0.67***	0.54***	0.6***	0.13*	0.09	-0.1	-0.08
Perceived usefulness (PU)	0.67***	1.0	0.59***	0.7***	0.14*	0.23***	-0.1	-0.08

Attitude toward use (ATT)	0.54***	0.59***	1.0	0.59***	0.18**	0.21***	-0.07	-0.02
Behavioural intention (BI)	0.6***	0.7***	0.59***	1.0	0.09	0.25***	-0.06	-0.07
Encouragement	0.13*	0.14*	0.18**	0.09	1.0	-0.14*	-0.05	-0.16*
Conditional Access	0.09	0.23***	0.21***	0.25***	-0.14*	1.0	0.06	0.01
Accuracy Concern	-0.1	-0.1	-0.07	-0.06	-0.05	0.06	1.0	0.07
Privacy Concern	-0.08	-0.08	-0.02	-0.07	-0.16*	0.01	0.07	1.0

Values represent Pearson correlation coefficients. Significance levels are indicated as follows: $p < 0.05$ (*), $p < 0.01$ (**), $p < 0.001$ (***). ATT, attitude toward use; BI, behavioural intention; PEOU, perceived ease of use; PU, perceived usefulness.

- Table S5. Ordinal logistic regression sensitivity analysis for behavioural intention

Predictor	Log-odds coefficient (SE)	Odds ratio	95% CI	p value
Perceived ease of use	0.48 (0.17)	1.61	1.16–2.25	0.005
Perceived usefulness	1.36 (0.20)	3.89	2.63–5.76	< 0.001
Attitude toward use	0.69 (0.15)	2.00	1.48–2.71	< 0.001
Organisational encouragement	-0.12 (0.13)	0.89	0.69–1.14	0.361
Conditional access	0.09 (0.13)	1.10	0.85–1.42	0.473
Accuracy concern	0.05 (0.26)	1.05	0.63–1.76	0.844
Privacy concern	-0.23 (0.24)	0.79	0.50–1.27	0.339
Age	-0.18 (0.12)	0.84	0.66–1.05	0.131

Proportional-odds ordinal logistic regression treating the nine observed behavioural intention values as ordered categories; $n = 257$. PEOU, PU, ATT, organisational encouragement, conditional access, and age were standardised; their odds ratios correspond to a one-standard-deviation increase. Accuracy and privacy concerns were entered as binary indicators (reference: concern not reported). $OR > 1$ indicates higher odds of reporting a higher behavioural intention category. Log likelihood = -368.00; AIC = 767.99. The ATT estimate should be interpreted cautiously because the reliability of the two-item ATT scale was below the predefined threshold. CI, confidence interval; SE, standard error.

- Table S6. Missing data overview

Variable	Missing (n)	Total (n)	Missing %
Age	1	258	0.4
Behavioural intention	0	258	0
Attitude toward use	0	258	0
Perceived usefulness	0	258	0
Perceived ease of use	0	258	0
Encouragement	0	258	0

Conditional Access	0	258	0
Accuracy Concern	0	258	0
Privacy Concern	0	258	0
Work Experience	0	258	0
Profession	0	258	0
Gender	0	258	0

- Table S7. Internal consistency of TAM constructs

	Number of items	Cronbach's α	Inter-item correlation (r)	Spearman-Brown coefficient
Total				
Perceived usefulness	5	0.82	-	-
Perceived ease of use	4	0.85	-	-
Attitude toward use	2	-	0.45	0.62
Behavioural intention	2	-	0.74	0.85
German sample				
Perceived usefulness	5	0.78	-	-
Perceived ease of use	4	0.78	-	-
Attitude toward use	2	-	0.43	0.61
Behavioural intention	2	-	0.72	0.84
Romanian sample				
Perceived usefulness	5	0.87	-	-
Perceived ease of use	4	0.89	-	-
Attitude toward use	2	-	0.48	0.65
Behavioural intention	2	-	0.81	0.89

Cronbach's α was calculated for multi-item scales (PU, PEOU). For two-item scales (ATT, BI), inter-item correlations and Spearman-Brown coefficients are reported. Values ≥ 0.70 are typically acceptable for internal consistency; lower values for two-item scales should be interpreted with caution.

- Table S8. Multicollinearity diagnostics (VIF)

Variable	VIFs
Perceived ease of use	1.99
Perceived usefulness	2.20
Attitude toward use	1.68
Encouragement	1.10
Conditional Access	1.15
Accuracy concern	1.03
Privacy concern	1.04
Age	1.05

VIFs, Variation inflation factors.

- Table S9. Comparison of survey completers and non-completers using available participant characteristics

Characteristic	Completers, n (%)	Non-completers, n (%)	Test statistic	p value	Cramér's V
Country			$\chi^2(3) = 1.45$	0.694	0.047

Germany	258 (56.0)	123 (60.0)			
Romania	185 (40.1)	75 (36.6)			
South Africa	13 (2.8)	4 (2.0)			
Netherlands	5 (1.1)	3 (1.5)			
Professional group			$\chi^2(6) = 33.85$	< 0.001	0.226
Psychosocial health professions	180 (39.0)	79 (38.7)			
Medical doctors	115 (24.9)	36 (17.6)			
Medical-technical and other health professions	73 (15.8)	29 (14.2)			
Nursing staff	46 (10.0)	30 (14.7)			
Therapeutic professions	22 (4.8)	2 (1.0)			
Administrative staff	17 (3.7)	8 (3.9)			
Other (free text)	8 (1.7)	20 (9.8)			
Workplace setting			$\chi^2(11) = 37.85$	< 0.001	0.239
Hospital	122 (26.5)	43 (21.2)			
Private practice / practitioner's practice	113 (24.5)	45 (22.2)			
Emergency medical services	68 (14.8)	30 (14.8)			
Mental health facility	37 (8.0)	17 (8.4)			
Community health center	25 (5.4)	7 (3.4)			
Outpatient clinic	25 (5.4)	11 (5.4)			
Education / research setting	18 (3.9)	3 (1.5)			
Public health department	17 (3.7)	4 (2.0)			
Other (free text)	15 (3.3)	31 (15.3)			
Rehabilitation center	9 (2.0)	4 (2.0)			
Nursing home / long-term care facility	8 (1.7)	4 (2.0)			
Ambulatory nursing services	4 (0.9)	4 (2.0)			
Mental-healthcare setting			$\chi^2(1) = 0.12$	0.730	0.013
Yes	200 (43.4)	91 (44.8)			
No	261 (56.6)	112 (55.2)			

Work experience, years, median (IQR)	13 (6–23)	10 (4–20)	W = 41,399	0.029	—
Exposure to language barriers, %, median (IQR)	10 (1–25)	5 (0–30)	W = 26,579.5	.112	—

Values are n (%) unless otherwise stated. Denominators vary because non-completers discontinued the questionnaire at different stages. Available observations for completers/non-completers were: country, 461/205; professional group, 461/204; workplace setting, 461/203; mental-healthcare setting, 461/203; work experience, 461/201; and exposure to language barriers, 457/128. Percentages are based on available responses for each variable. Pearson chi-square tests were used for categorical variables and Wilcoxon rank-sum tests for continuous or ordinal variables. Cramér's V is reported for categorical comparisons. IQR, interquartile range.

- Table S10. Diagnostic results for the adjusted OLS regression model

Diagnostic	Result	Interpretation
Participants at the maximum BI score	34/258 (13.2%)	Some clustering at the upper end of the BI scale
Breusch-Pagan test	$\chi^2(8) = 24.20$; $p = 0.002$	Evidence of heteroscedasticity
Shapiro-Wilk test of residuals	W = 0.984; $p = 0.005$	Modest tail deviations from residual normality
Maximum Cook's distance	0.061	No observation approached the conventional threshold of 1
Cook's distance > 4/n	20 observations	Observations exceeding the screening threshold were examined for potential influence
Cook's distance > 1	0 observations	No highly influential observation according to this threshold

The distribution of behavioural intention was assessed in the full German sample (N = 258). Residual diagnostics were based on the adjusted OLS model (n = 257), which included PEOU, PU, ATT, organisational encouragement, conditional access, accuracy concern, privacy concern, and age. Because the Breusch-Pagan test indicated heteroscedasticity, HC3 heteroscedasticity-consistent confidence intervals and p values were used for the main inferential reporting. BI, behavioural intention; Q–Q, quantile-quantile. OLS, ordinary least squares.

Model 2 residuals versus fitted values

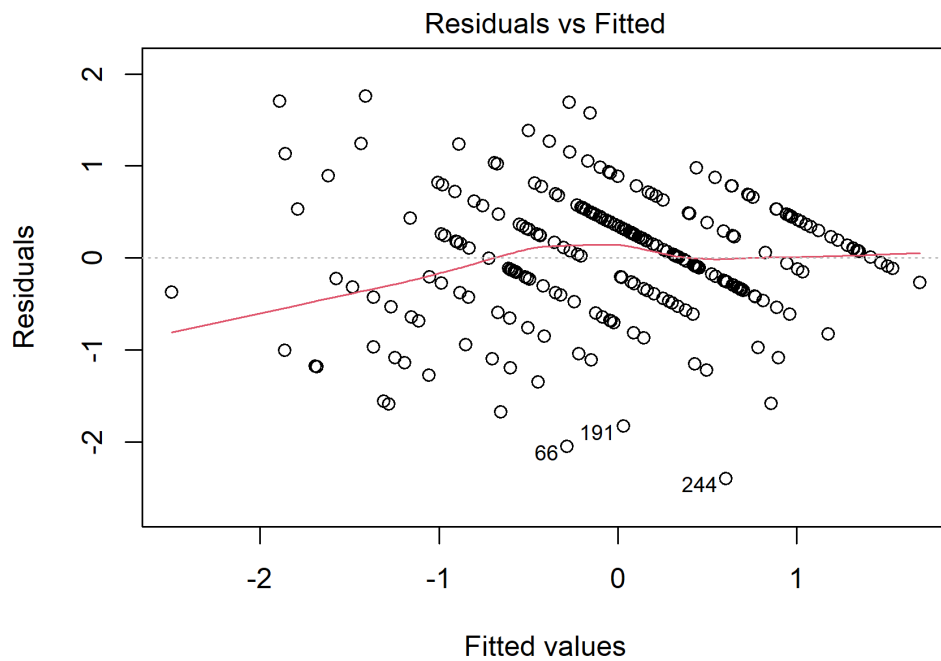


Figure S 1. Residuals versus fitted values, used to assess the residual pattern and heteroscedasticity

Model 2 normal Q-Q plot

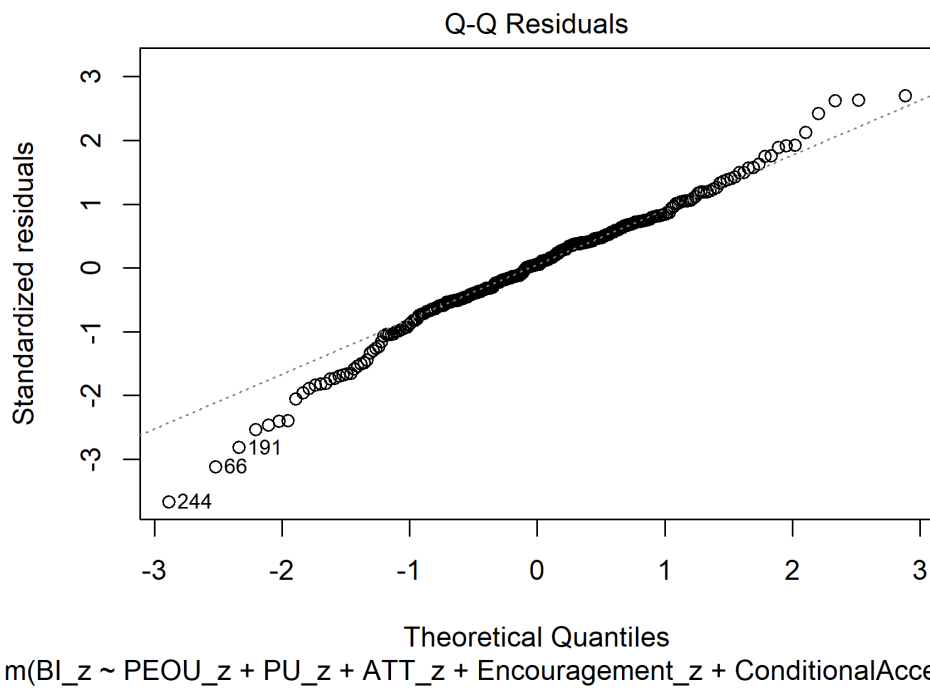
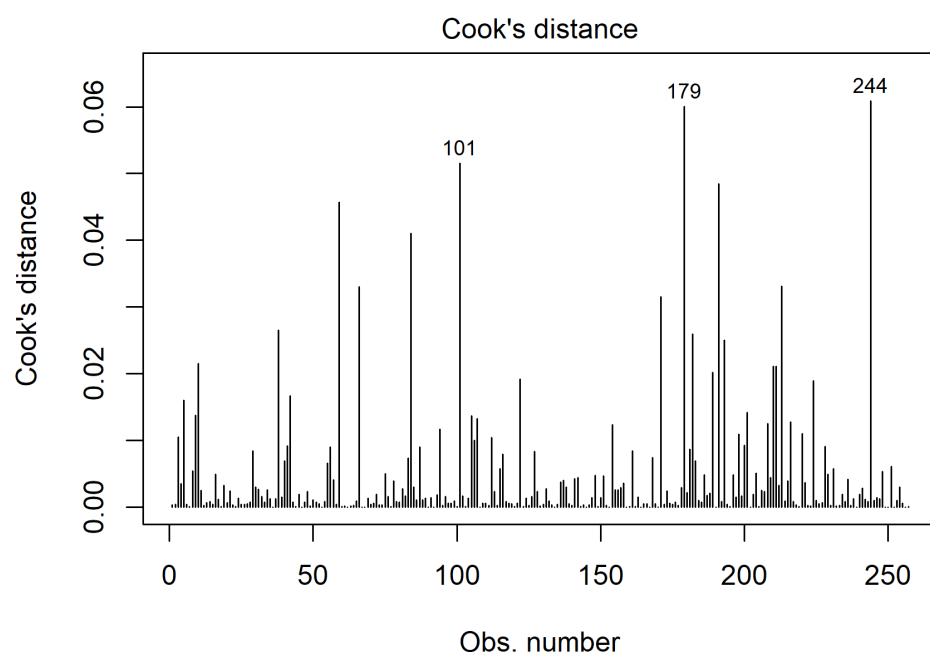


Figure S 2. Normal Q-Q plot of the model residuals, used to assess departures from residual normality.

Model 2 Cook's distance



$m(\text{BI_z} \sim \text{PEOU_z} + \text{PU_z} + \text{ATT_z} + \text{Encouragement_z} + \text{ConditionalAccess_z})$

Figure S 3. Cook's distance for individual observations, used to identify potentially influential cases.

- Table S11. Sensitivity analyses including exposure to language barriers and expanded covariate adjustment

Variable	Exposure model β (95% CI)	p value	Expanded model β (95% CI)	p value
Perceived ease of use	0.18 (0.04–0.33)	0.011	0.15 (0.0004–0.29)	0.049
Perceived usefulness	0.42 (0.25–0.59)	< 0.001	0.44 (0.26–0.61)	< 0.001
Attitude toward use	0.22 (0.11–0.34)	< 0.001	0.20 (0.07–0.32)	0.002
Organisational encouragement	-0.02 (-0.12–0.08)	0.700	-0.02 (-0.13–0.08)	0.643
Conditional access	0.08 (-0.03–0.18)	0.141	0.04 (-0.06–0.15)	0.437
Accuracy concern	0.03 (-0.16–0.22)	0.779	0.02 (-0.17–0.20)	0.848
Privacy concern	-0.05 (-0.22–0.13)	0.610	-0.01 (-0.19–0.17)	0.883
Age	-0.07 (-0.15–0.006)	0.072	-0.06 (-0.26–0.15)	0.577
Exposure to language barriers	-0.002 (-0.10–0.09)	0.972	-0.004 (-0.10–0.09)	0.943
Work experience	—	—	0.004 (-0.20–0.20)	0.972
Mental-healthcare setting: yes	—	—	-0.06 (-0.36–0.24)	0.692
Gender: male	—	—	-0.11 (-0.33–0.10)	0.290
Gender: other / prefer not to answer	—	—	-0.29 (-0.94–0.37)	0.390
Professional group				
Medical doctors	—	—	0.46 (0.10–0.82)	0.012
Nursing staff	—	—	0.25 (-0.13–0.63)	0.191
Medical-technical and other health professions	—	—	0.34 (-0.02–0.71)	0.065
Therapeutic professions	—	—	0.43 (-0.12–0.98)	0.125
Administrative staff	—	—	0.22 (-0.32–0.76)	0.416

Other (free text)	—	—	0.48 (-1.31–2.28)	0.597
Model fit				
<i>n</i>	254		254	
<i>R</i> ²	0.569		0.604	
Adjusted <i>R</i> ²	0.553		0.572	
AIC	528.152		526.318	
BIC	567.063		600.602	

Standardised OLS regression coefficients are reported with HC3 heteroscedasticity-consistent 95% confidence intervals and p values. The exposure model added self-reported exposure to language barriers to the primary adjusted model. The expanded model additionally included work experience, mental-healthcare setting, gender, and professional group. Continuous predictors were standardised. Reference categories were no mental-healthcare setting, female gender, and psychosocial health professions. Accuracy and privacy concerns were entered as binary indicators (reference: concern not reported). ATT estimates should be interpreted cautiously because the reliability of the two-item ATT scale was below the predefined threshold. AIC, Akaike information criterion; BIC, Bayesian information criterion; CI, confidence interval; ATT, attitude toward use; BI, behavioural intention; PEOU, perceived ease of use; PU, perceived usefulness.