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Original Article

Awareness, Knowledge, and Attitudes of Family Physicians Towards Telemedicine: Across-Sectional Study

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Abstract

Introduction: The successful integration of telemedicine into primary care depends largely on its acceptance by family physicians, who function as gatekeepers. Although global research on telemedicine adoption has expanded, significant gaps persist regarding family physicians practicing in diverse socio-cultural contexts, such as Iran. This study aimed to assess the awareness, knowledge, and attitudes of family physicians in Hamadan Province, Iran, toward telemedicine and to identify associated demographic and professional factors.

Methods: A descriptive-analytical cross-sectional study was conducted in 2020 among family physicians working in comprehensive health service centers affiliated with Hamadan University of Medical Sciences. Using stratified random sampling, 182 physicians were selected. Data were collected using a validated, multidimensional questionnaire based on established technology acceptance frameworks. The instrument assessed awareness (12 items), knowledge (10 items), and attitudes (9 items). Statistical analyses included descriptive statistics, one-way ANOVA, and multiple linear regression.

Results: Mean total scores were 38.9 ± 9.4 (range 12–60) for awareness, 6.6 ± 2.1 (range 0–10) for knowledge, and 34.2 ± 6.8 (range 9–45) for attitudes, indicating moderate awareness, moderate knowledge, and moderate-to-high attitudes. Regression analyses indicated that work experience significantly predicted awareness ($\beta = 0.38$, $P < 0.001$), knowledge ($\beta = 0.22$, $P < 0.001$), and attitudes ($\beta = 0.12$, $P = 0.003$). Younger age was associated with higher knowledge scores ($P = 0.004$). Furthermore, male physicians reported significantly more positive attitudes than their female counterparts ($P = 0.042$). Significant variations were also observed across workplace locations, with urban centers generally demonstrating higher knowledge scores.

Conclusion: Family physicians in Hamadan Province demonstrate a foundational yet moderate level of readiness for telemedicine adoption. These findings underscore the need for tailored, multi-faceted interventions. Recommended strategies include demographic-specific educational programs (particularly for older physicians and those in rural areas), investment in digital infrastructure in underserved regions, and gender-responsive training approaches. Such measures are essential for promoting the equitable and effective integration of telemedicine into Iran's primary healthcare system.

Keywords: Telemedicine, Family physicians, Awareness, Knowledge, Attitudes, Primary health care, Cross-sectional study, Iran

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Introduction

Telemedicine refers to the remote delivery of healthcare services through information and communication technologies (ICTs) and has evolved from a niche innovation to a central component of modern healthcare systems (1). The global coronavirus disease 2019 (COVID-19) pandemic demonstrated the capability of telemedicine to increase access to services, reduce costs, and enhance healthcare delivery (2). While the technology for telemedicine is important, a sustainable model is largely contingent on healthcare providers' knowledge, awareness, and attitudes toward such innovations (3, 4).

Family physicians constitute the cornerstones of primary healthcare and play a crucial role in the successful adoption of telemedicine. Because they provide continuous and comprehensive care, they are fundamental to implementing remote consultations, patient monitoring, and digital health management (5). Therefore, understanding family physicians' skills and beliefs is crucial for the development of effective digital health strategies.

Research conducted in various countries, such as Egypt, Germany, and Ethiopia, indicates that telemedicine adoption is shaped by a complex interaction of factors, including access to training, technical infrastructure, and digital literacy (6-8). Nevertheless, there is a marked geographical bias in the literature, and much of the research originates from high-income countries, resulting in a paucity of literature on telemedicine readiness among specific middle-income countries with distinct health systems, such as Iran.

In Iran, the Family Physician Program is an integral part of the primary care system and serves large populations, mainly in rural and semi-urban areas (9). Although digital health technologies could play a strategic role in addressing geographic disparities in healthcare access, there is scant evidence regarding the preparedness of Iranian family physicians to adapt to such technologies. Sociocultural dynamics, healthcare policy issues, and infrastructure constraints may shape physicians' perceptions in ways that differ from those observed in other settings. To date, no study has systematically examined the family physicians' awareness, knowledge, and attitudes toward telemedicine across a province in Iran.

The present study addresses this pivotal gap in the evidence base by investigating telemedicine awareness, knowledge, and attitudes among family physicians in Hamadan Province, Iran. The results aim to provide context-specific evidence to inform educational programs and policies and to contribute a valuable and missing perspective to the global telemedicine literature.

Materials and Methods

Study Design and Setting

A descriptive-analytical cross-sectional study was applied to assess family physicians' awareness, knowledge, and attitudes regarding telemedicine technology. Cross-sectional designs allow point-in-time estimates of population characteristics and are time-saving for hypothesis testing and generalization within a specific context (10). The study was conducted in 2020 across all comprehensive health service centers affiliated with Hamadan University of Medical Sciences in Hamadan Province, Iran. This setting represents several urban and rural primary care environments, thereby allowing stratified analyses of geographic influences on telemedicine adoption.

Population and Sampling

The target population included all registered family physicians actively practicing in comprehensive health service centers in Hamadan Province (N ≈ 350, based on provincial health records). Sample size was determined using an *a priori* power analysis in G*Power software (version 3.1.9.7). For a one-way ANOVA with an effect size of f = 0.25 (Cohen's convention for a medium effect), α = 0.05, power = 0.80, and three groups, a minimum of 159 participants was required. Accounting for an anticipated non-response rate of approximately 15%, the target sample size was increased to 182, all of whom were successfully recruited, exceeding the minimum requirement and ensuring sufficient statistical power for the analyses.

Stratified random sampling ensured proportional representation across strata: urban (60%) vs. rural (40%) service locations. Within each stratum, simple random sampling was performed using a random number generator in R software (version 4.3.1), minimizing the risk of selection bias, thereby promoting external validity as compared to comparing non-stratified methods (11-14). Recruitment was ensured through coordination with the extension unit of Hamadan University of Medical Sciences. Study aims were explained in a structured presentation during the in-service training sessions, after which informed consent was obtained. Non-respondents were followed up with once via email or telephone to mitigate attrition bias.

Data Collection Instrument

A multi-dimensional questionnaire developed by researchers was the primary instrument for data collection. The instrument was based on established telemedicine frameworks such as the Technology Acceptance Model (TAM; Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003). The instrument consisted of four sections: (1) Demographic variables (gender [binary], age [continuous and categorical for analysis], years of professional experience [continuous], and workplace location [urban/rural]); (2) Awareness (12 items on a 5-point Likert scale, 1 = very low, 5 = very high); (3) Knowledge (10 dichotomous items, yes = 1, no = 0, total score range 0-10); and (4) Attitudes (9 items on a 5-point Likert scale, 1 = completely disagree, 5 = completely agree). Items were derived from a systematic literature review (e.g., scales adapted from Haleem et al., 2021) and refined through successive rounds of expert consultation in health informatics and primary care.

Forthcoming research in instrument refinement involved pilot testing with 30 family physicians who were excluded from the main sample. Cognitive interviews assessed item clarity and response burden, yielding a mean completion time of 12 minutes.

The awareness subscale consisted of 12 items rated on a 5-point Likert scale (1 = very low to 5 = very high). Total scores ranged from 12 to 60, with higher scores indicating greater awareness. The knowledge subscale (10 dichotomous items: Yes/No) yielded scores ranging from 0 to 10, with higher scores reflecting greater knowledge.

The attitude subscale comprised 9 items on a 5-point Likert scale (1 = completely disagree to 5 = completely agree), with total scores ranging from 9 to 45 (higher scores reflecting more positive attitudes). For interpretive purposes, mean awareness and attitude scores were categorized as low (< 3.0), moderate (3.0–3.99), or high (≥ 4.0), while knowledge scores were classified as low (< 6), moderate (6–7.99), or high (≥ 8).

Validity and Reliability

Validity was assessed through multiple methods. Content validity was determined with the Content Validity Ratio (CVR) calculated by 10 experts (health informatics specialists, family physicians, methodologists), resulting in a mean CVR of 0.82, exceeding the critical value of 0.62 for 10 experts. The Content Validity Index (CVI) for relevance, simplicity, and clarity was 0.85. Construct validity was measured through exploratory factor analysis (EFA) on pilot data, using principal axis factoring with varimax rotation in SPSS (version 27). Kaiser-Meyer-Olkin (KMO) measure was 0.78 (adequate sample), and Bartlett's test of sphericity was significant ($P < 0.001$). EFA yielded a three-factor solution corresponding to awareness, knowledge, and attitudes, accounting for 68.4% of the total variance, with factor loadings > 0.40 and no cross-loadings > 0.30.

Reliability was determined through internal consistency and temporal stability. Overall, Cronbach's alpha was α = 0.87, with subscales: awareness α = 0.82 and attitudes α = 0.89. Knowledge reliability assessed using the Kuder-Richardson Formula 20 (KR-20) was 0.81. Temporal stability through test-retest (pilot) was examined over a 14-day interval in the pilot sample, yielding intraclass correlation coefficients (ICC) ranging from 0.82 to 0.90 (95% CI: 0.75–0.94), exceeding recommended thresholds (11-14) for psychometric properties.

Data Analysis

Data were then analyzed using R software (version 4.3.1), using the *psych* for psychometric analysis, *lavaan* for advanced modeling, and *mice* for missing data imputation. Descriptive statistics, including means (± SD), medians (IQR), frequencies, and percentages, were calculated for a demographic stratification original to the study sample. Data normality was tested using Shapiro-Wilk tests and Q-Q plots, which were modified with transformations (e.g., log), as appropriate. Although the *lavaan* package was initially employed for exploratory assessment of potential latent structures, confirmatory structural equation modeling was not a primary objective of this study, and the sample size was ultimately more suited to the reported analyses.

Advanced inferential techniques were used to test the hypothesized principles:

- Multivariable linear regression analysis assessed associations between telemedicine dimensions (dependent variables: awareness, knowledge, attitudes scores) and predictors (age, gender, work experience, workplace location), controlling for confounding variables and testing interactions (e.g., age × place of service). Model fit was assessed via adjusted R^2, F-tests, and Akaike Information Criterion (AIC).
- One-way multivariate analysis of variance (MANOVA) examined group differences across multiple dependent variables simultaneously according to predefined categorical factors (e.g., age groups: < 35, 35-45, > 45 years; workplace location), followed by Bonferroni-adjusted univariate ANOVAs for post-hoc comparisons.
- Structural equation modeling (SEM) using maximum likelihood estimation explored latent relationships between awareness, knowledge, and attitudes, checking fit indices using established criteria (CFI > 0.95, RMSEA < 0.06, and SRMR < 0.08).

Results

In 2020, a total of 182 family physicians from comprehensive health service centers in Hamadan Province participated in the study. Mean total scores were 38.9 ± 9.4 (out of 60) for awareness, 6.6 ± 2.1 (out of 10) for knowledge, and 34.2 ± 6.8 (out of 45) for attitudes, corresponding to mean item scores of 3.24 ± 0.78, 6.6 ± 2.1, and 3.80 ± 0.76, respectively. Based on predefined cutoffs, these findings indicate moderate awareness, moderate knowledge, and moderate-to-high attitudes toward telemedicine.

The proportions of female (61.53%, n = 112) and male (37.91%, n = 69) respondents are presented in Table 1: missing data were negligible (0.56%). The age distribution (Table 1) peaked at 31-35 years (40.10%, n = 73), followed by 26-30 years (26.50%, n = 48). Each of the age groups 20-25, 36-40, 41-45, and 46-50 years accounted for 8.24% (*n* = 15). Missing data for age constituted 0.44%. The mean work experience of respondents was 6.41 years (SD = 0.51 years). The distribution of workplaces is presented in Table 1, with the most represented being Malayer (19.23%, n = 35), Razan (14.28%, n = 26), and Nahavand (13.73%, n = 25), whereas Hamadan was the least represented (2.19%, n = 4). Distances from Hamadan ranged from 14.11 km (Bahar) to 84.40 km (Razan). Overall, the very low proportion of missing data and the demographic variability shown in Table 1 indicate that the dataset was satisfactory for statistical analysis of telemedicine adoption factors.

Table 2 presents the frequency distribution and percentages of responses from the participants (n = 182) across the 12 awareness items in the questionnaire. Awareness levels were measured using a five-point Likert scale (very high = 5, high = 4, moderate = 3, low = 2, very low = 1). The overall distribution of responses indicated moderate-to-high awareness: very high (12.13%), high (33.15%), and moderate (30.72%). In contrast, 15.75% and 8.24% of respondents reported low and very low awareness, respectively. The mean overall awareness score was 3.25 (out of 5), indicating a moderate-to-high level of

Table 1. Demographic and Occupational Characteristics of Participants (N = 182)

Qualitative Variable	Category	Frequency (%)
Sex	Male	69 (37.91)
	Female	112 (61.54)
	Missing Data	1 (0.55)
Age (years)	20 to 25	15 (8.24)
	26 to 30	48 (26.37)
	31 to 35	73 (40.11)
	36 to 40	15 (8.24)
	41 to 45	15 (8.24)
	46 to 50	15 (8.24)
	Missing Data	1 (0.55)
Workplace Location	Location 1 (Asadabad, Distance to location 9: 35.75 Km)	20 (10.99)
	Location 2 (Bahar, Distance to location 9: 14.11 Km)	23 (12.64)
	Location 3 (Toisarkan, Distance to location 9: 28.11 Km)	22 (12.09)
	Location 4 (Razan, Distance to location 9: 84.40 Km)	26 (14.29)
	Location 5 (Kaboudarahang, Distance to location 9: 49.97 Km)	20 (10.99)
	Location 6 (Nahavand, Distance to location 9: 69.26 Km)	25 (13.74)
	Location 7 (Malayer, Distance to location 9: 61.59 Km)	35 (19.23)
	Location 8 (Famenin, Distance to location 9: 55.02 Km)	7 (3.85)
	Location 9 (Hamadan)	4 (2.20)
Quantitative Variable	**Scale**	**Mean (SD)**
Work Experience	years	6.41 ± 0.51

Table 2. Frequency Distribution and Percentage of Responses to Awareness Items (n = 182)

Item	Very High n (%)	High n (%)	Moderate n (%)	Low n (%)	Very Low n (%)	Total (%)
ICT can be used effectively in healthcare services	22 (12.1)	68 (37.4)	54 (29.7)	24 (13.2)	14 (7.7)	100.0
ICT services enable access to the latest advances in medicine.	34 (18.7)	81 (44.5)	38 (20.9)	22 (12.1)	7 (3.8)	100.0
Telemedicine is a part of information technology in medicine	23 (12.6)	66 (36.3)	65 (35.7)	21 (11.5)	7 (3.8)	100.0
Telemedicine and e-health are synonymous terms	5 (2.7)	55 (30.2)	63 (34.6)	35 (19.2)	24 (13.2)	100.0
Telemedicine enables face-to-face communication between patients and doctors.	6 (3.3)	18 (9.9)	84 (46.2)	42 (23.1)	32 (17.6)	100.0
Telemedicine provides healthcare services where distance is a barrier.	21 (11.5)	51 (28.0)	71 (39.0)	27 (14.8)	12 (6.6)	100.0
Telemedicine enables the transmission of medical images to specialists for consultation.	47 (25.8)	52 (28.6)	51 (28.0)	25 (13.7)	7 (3.8)	100.0
Telemedicine enables electronic visits for elderly patients.	32 (17.6)	45 (24.7)	40 (22.0)	46 (25.3)	19 (10.4)	100.0
Doctors in rural areas can send ECG or X-ray images to specialists for consultation	22 (12.1)	79 (43.4)	41 (22.5)	28 (15.4)	12 (6.6)	100.0

Note. N: Total number of participants; n: Number of respondents; ICT: Information and communication technology; ECG = Electrocardiogram.

awareness.

The highest mean score (3.62) corresponded to the item stating that "ICT services enable access to the latest advances in medicine", indicating relatively strong awareness of this proportion. The lowest mean score (2.58) was observed for the item "Telemedicine enables face-to-face communication between a patient and a doctor," which may reflect a misunderstanding of telemedicine. Overall, awareness of practical applications of telemedicine (e.g., transmission of medical images) was greater than awareness of conceptual aspects (e.g., synonymity of telemedicine and e-health). These findings suggest that educational programs should clarify conceptual ambiguities.

Table 3 depicts the distribution of responses from the 182 respondents across the 10 items in the second part of a questionnaire evaluating knowledge of telemedicine. Agreement was highest regarding telemedicine's ability to provide medical information (78%), shared clinical test results (76%), and facilitate patient scheduling (79.1%). Moderate agreement was observed for managing medication (59.3% yes) and direct patient consultations (52.7% yes), while the lowest level of agreement was found for remote surgery (41.7% yes), perhaps reflecting skepticism or limited familiarity. In general, these results indicate a positive understanding of the fundamentals of telemedicine capabilities, alongside a need for more education regarding advanced applications.

Table 4 shows the distribution of attitudes among family physicians, revealing an overall positive yet somewhat nuanced disposition toward telemedicineand health information technology (IT). Strong agreement (73.0% agree/completely agree) regarding the necessity of computer and ICT knowledge for the medical profession suggests, at least, a starting acknowledgment that an initial recognition of its essential importance. In addition, a majority of physicians (59.5% agree/completely agree) expressed personal willingness to engage in telemedicine training, signifying readiness for adoption. However, substantial undecidedness in several items, especially concerning telemedicine's ability to eliminate differences between primary and secondary care (33.5% undecided) and its potential to easily provide health benefits for all (28.0% undecided), indicates some uncertainty or a

Table 3. Frequency Distribution and Percentage of Responses to Items in the Second Part of the Questionnaire (Knowledge)

Item	No, n (%)	Yes, n (%)
Telemedicine provides medical information and services using remote communication.	40 (22.0)	142 (78.0)
Healthcare delivery via the Internet is a well-known service.	76 (41.8)	106 (58.2)
Telemedicine can help manage patients' medication intake.	74 (40.7)	108 (59.3)
Direct consultation with patients is possible through telemedicine.	86 (47.3)	96 (52.7)
Direct consultation with other doctors and specialists is possible through telemedicine.	50 (27.5)	132 (72.5)
Patients' test results can be shared via telemedicine.	44 (24.2)	138 (75.8)
Sharing patients' medical records is possible through telemedicine.	40 (22.0)	142 (78.0)
Continuing the patients' treatment process is possible through telemedicine.	48 (26.4)	134 (73.6)
Performing remote surgery is possible through telemedicine	106 (58.2)	76 (41.8)
Patient scheduling and registration can be conducted via telemedicine.	37 (20.3)	145 (79.7)

Table 4. Frequency Distribution and Percentage of Responses to Attitude Items (n = 182)

No.	Item	Completely Agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Completely Disagree n (%)	Total (%)
1	More information about computers and ICT in medicine is necessary for various medical professions.	33 (18.1)	100 (54.9)	45 (24.7)	4 (2.2)	0 (0.0)	99.9
2	Telemedicine has strengthened and encouraged teamwork, leading to improved quality of healthcare.	36 (19.8)	85 (46.7)	48 (26.4)	11 (6.0)	2 (1.1)	100.0
3	The use of ICT in medicine reduces the government's financial burden.	32 (17.6)	74 (40.7)	55 (30.2)	21 (11.5)	0 (0.0)	100.0
4	Universal health coverage can be easily achieved through the use of ICT.	57 (31.3)	56 (30.8)	51 (28.0)	15 (8.2)	3 (1.6)	99.9
5	As a doctor, I am willing to participate in telemedicine training courses.	60 (33.0)	48 (26.4)	53 (29.1)	18 (9.9)	3 (1.6)	100.0
6	Patients should be encouraged to use the internet and websites to obtain more information about their disease.	36 (19.8)	66 (36.3)	54 (29.7)	17 (9.3)	9 (4.9)	100.0
7	Telemedicine, along with easy access to health and medical information for the general public, will lead to the development of a healthier society in the future.	52 (28.6)	57 (31.3)	54 (29.7)	16 (8.8)	3 (1.6)	100.0
8	Telemedicine, by improving collaboration between doctors and nurses, will reduce the distinction between primary and secondary care.	40 (22.0)	60 (33.0)	61 (33.5)	19 (10.4)	2 (1.1)	100.0
9	Telemedicine can promote teamwork in healthcare and expand services by placing greater emphasis on disease prevention.	26 (14.3)	84 (46.2)	54 (29.7)	15 (8.2)	3 (1.6)	100.0

need for more evidence regarding its greater systemic implications. The lowest level of agreement was observed for the item stating that telemedicine reduces the government's financial burden (58.3% agree/completely agree), with an 11.5% disagreement rate, further emphasizing uncertainty about cost-effectiveness. Taken together, these findings indicate that although family physicians are generally prepared to accept digital health tools, successful integration will need to address specific concerns regarding economic implications, role clarity, and the realistic expectations of telemedicine benefits through targeted education and policy reform.

Telemedicine readiness displayed dissimilar patterns with regard to demographic influences (Table 5). Sex was statistically associated with differences in attitudes ($P = 0.042$), with male physicians showing more positive scores. Age dominated all significant influences across all domains ($P < 0.017$), with the youngest cohort (20-25 years) demonstrating the highest knowledge levels and the most favorable attitudes, alongside comparatively positive outcomes among the middle-aged groups. In contrast, geographic variation significantly affected knowledge ($P = 0.020$), with Famenin and Razan exhibiting the highest scores and Toyserkan the lowest. No geographic differences emerged for awareness or attitudes, indicating common perceptual grounds across locations despite variable levels of knowledge. Hence, these results depict a complex interplay among demographic variables and telemedicine competencies, suggesting that successful implementation will require additional multidimensional strategies designed to address these specific disparities.

Distinct predictive patterns across telemedicine competencies were identified through multiple regression analysis (Table 6). Work experience emerged as the strongest positive predictor of telemedicine competencies, with marked regression effects on awareness ($\beta = 0.38$, $P < 0.001$), knowledge ($\beta = 0.22$, $P < 0.001$), and attitudes ($\beta = 0.12$, $P = 0.003$). Age exhibited significant negative associations with awareness ($\beta = -0.18$, $P < 0.001$) and knowledge ($\beta = -0.28$, $P < 0.001$), but did not significantly affect attitudes. Male gender was associated with more favorable attitudes ($\beta = 0.22$, $P < 0.001$) and higher knowledge scores ($\beta = 0.18$, $P = 0.047$); moreover, workplace location significantly influenced knowledge ($\beta = 0.32$, $P < 0.001$). The models accounted for 13-23% of the variance in outcomes, with awareness showing the

Table 5. Comparison of Awareness, Knowledge, and Attitudes Scores by Demographic Characteristics

Category	Subcategory	Awareness Mean ± SD	*P*-value	Knowledge Mean ± SD	*P*-value	Attitudes Mean ± SD	*P*-value
Sex	Male	3.35 ± 0.78	0.159	6.93 ± 3.25	0.345	3.95 ± 0.64	0.042*
	Female	3.15 ± 0.68		6.32 ± 3.48		3.68 ± 0.71	
Age (years)	20-25	3.45 ± 0.75	0.017*	9.45 ± 0.93	0.004*	4.25 ± 0.65	0.005*
	26-30	3.10 ± 0.70		6.37 ± 3.24		3.72 ± 0.66	
	31-35	3.03 ± 0.70		5.07 ± 3.75		3.59 ± 0.70	
	36-40	3.35 ± 0.98		6.45 ± 4.18		3.53 ± 0.76	
	41-45	3.67 ± 0.40		7.50 ± 2.80		4.24 ± 0.50	
	46-50	3.68 ± 0.40		8.00 ± 0.90		4.07 ± 0.36	
Workplace Location	Location 1 (Asadabad)	3.15 ± 0.41	0.100	5.69 ± 2.78	0.020*	3.85 ± 0.50	0.130
	Location 2 (Bahar)	3.16 ± 0.75		6.13 ± 4.00		3.67 ± 0.69	
	Location 3 (Toyserkan)	2.78 ± 0.78		2.60 ± 3.87		3.13 ± 0.74	
	Location 4 (Razan)	3.59 ± 0.61		8.35 ± 2.67		4.15 ± 0.84	
	Location 5 (Kabudarahang)	3.56 ± 0.60		7.30 ± 2.10		3.88 ± 0.63	
	Location 6 (Nahavand)	2.43 ± 0.59		5.94 ± 3.99		3.64 ± 0.70	
	Location 7 (Malayer)	3.68 ± 0.34		7.91 ± 0.73		3.93 ± 0.48	
	Location 8 (Famenin)	3.38 ± 0.84		9.20 ± 0.84		4.14 ± 0.49	
	Location 9 (Hamadan)	3.72 ± 0.13		8.00 ± 0.00		4.10 ± 0.57	

Table 6. Regression Coefficients for Factors Associated with Telemedicine Competencies

Dependent Variable	Predictor	β (Coefficient)	SE	t-value	*P*-value	95% Confidence Interval	VIF	Partial η²	Adjusted R²
Awareness	Intercept	2.90	0.22	13.18	< 0.001	[2.47, 3.33]	-	-	0.23
	Work Experience	0.38	0.04	9.50	< 0.001	[0.30, 0.46]	1.8	0.18	
	Age	-0.18	0.05	-3.60	< 0.001	[-0.28, -0.08]	2.1	0.06	
	Sex (Male)	0.12	0.07	1.71	0.089	[-0.02, 0.26]	1.5	0.02	
	Workplace	0.06	0.03	2.00	0.047	[0.001, 0.12]	2.3	0.03	
Knowledge	Intercept	8.60	0.55	15.64	< 0.001	[7.51, 9.69]	-	-	0.19
	Work Experience	0.22	0.06	3.67	< 0.001	[0.10, 0.34]	1.9	0.08	
	Age	-0.28	0.07	-4.00	< 0.001	[-0.42, -0.14]	2.2	0.10	
	Sex (Male)	0.18	0.09	2.00	0.047	[0.003, 0.36]	1.6	0.03	
	Workplace	0.32	0.09	3.56	< 0.001	[0.14, 0.50]	2.5	0.09	
Attitudes	Intercept	3.65	0.18	20.28	< 0.001	[3.29, 4.01]	-	-	0.13
	Work Experience	0.12	0.04	3.00	0.003	[0.04, 0.20]	1.7	0.06	
	Age	-0.07	0.05	-1.40	0.163	[-0.17, 0.03]	2.0	0.01	
	Sex (Male)	0.22	0.06	3.67	< 0.001	[0.10, 0.34]	1.4	0.09	
	Workplace	0.03	0.02	1.50	0.135	[-0.01, 0.07]	2.4	0.02	

Note. β = Unstandardized regression coefficient; SE: Standard error; CI: Confidence interval; VIF: Variance inflation factor; η² (Partial eta squared): Effect size; Adjusted R²: Adjusted coefficient of determination.

best model fit ($R^2 = 0.23$). All variance inflation factors were below 2.5, indicating acceptable multicollinearity. These findings suggest that professional experience boosts telemedicine competencies overall, that knowledge acquisition is particularly sensitive to contextual and demographic factors, and that attitudes appear less sensitive to gender and experience.

Discussion

This cross-sectional study elucidates the complex relationships between demographic characteristics and telemedicine competency utilization among family physicians in Hamadan Province, Iran. The findings reveal patterns that enhance understanding of telemedicine adoption in developing healthcare contexts.

Multivariate regression analysis identified work experience as the strongest positive predictor of awareness across all three competency domains (B = 0.38, $P < 0.001$). Interestingly, this finding is in sharp contrast to the conventional assumption that younger "digital natives" adapt well to the telemedicine environments. Instead, it indicates that the veteran clinician with extensive clinical experience may be better positioned to recognize how digital tools can address real-life clinical challenges, beyond mere technical familiarity. This finding aligns with that of Alvarado-Villa et al. (11), who reported that experienced clinicians develop more feedback skills on integrating digital tools into clinical problem-solving.

Evidence clearly indicates the presence of a generational digital divide, with physicians aged 20-25 exhibiting significantly higher digital health knowledge scores (9.45 ± 0.93) than their older counterparts. The same patterns have been reported internationally, including studies conducted in Saudi Arabia and Germany, confirming that younger healthcare professionals tend to have higher digital health literacy (15-17). However, our findings reveal a more complex pattern. Although younger physicians displayed stronger technical knowledge, attitudinal features were also comparably positive among both younger practitioners and those aged 41-45. These results suggest that favorable attitudes toward telemedicine are not rigidly age-dependent but may instead reflect the combined influence of digital nativity and clinical maturity, both of which contribute to improvements in clinical practice through telemedicine.

Geographic inequality further highlighted the clear cutoff between the best-performing (Famenin: 9.20 ± 0.84) and worst-performing (Toyserkan: 2.60 ± 3.87) districts, indicating substantial regional differences in digital infrastructure and training opportunities. Notably, Toyserkan recorded the lowest score despite not being the most geographically remote area, suggesting that underlying factors contributing to these disparities extend beyond distance from the provincial center and may include localized socioeconomic conditions, the frequency of targeted investments, or historical development priorities. This finding is consistent with prior studies from Ethiopia identifying IT access and technical support as important predictors of telemedicine usage (16, 18), underscoring the need for context-specific infrastructure analysis. Gender differences displayed a more subtle pattern, with male physicians showing slightly higher knowledge scores ($\beta = 0.18$, $P = 0.047$) and markedly more positive attitudes toward telemedicine ($\beta = 0.22$, $P < 0.001$). While this pattern partially matches findings from Saudi Arabia (16), the small effect sizes ($\beta < 0.30$) require cautious interpretation. Though statistically significant, these differences are unlikely to represent major determinants of telemedicine competency. Rather, they might reflect underlying sociocultural influences, such as differential access to technology-based continuing education, gendered social expectations regarding technology adoption, or variations in self-efficacy across genders—elements that extend beyond simplistic gender dichotomy.

Limitations and Interpretation

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes causal inferences. Second, the modest explanatory power of the regression models ($R^2 = 0.13$-0.23) indicates that a substantial proportion of variance in telemedicine competencies remains unexplained by demographic factors alone. This suggests that future research should incorporate organizational, technological, and psychological variables that more directly influence telemedicine adoption. Indeed, Garavand et al.'s (19) systematic review emphasized the paramount importance of organizational factors (e.g., workflow integration, leadership support), technological considerations (e.g., usability, interoperability), and psychological elements (e.g., perceived usefulness, behavioral control) in shaping healthcare professionals' engagement with telemedicine.

Despite these limitations, our study provides valuable insights into demographic correlates of telemedicine competencies in an understudied regional context, offering baseline data for future interventions and policy development.

Conclusion

These findings indicate a foundational level of telemedicine readiness among family physicians in Hamadan Province, Iran, while highlighting significant variations associated primarily with experience and geography, and to a lesser extent with age and gender. Mean total scores were 38.9 ± 9.4 (range 12–60) for awareness, 6.6 ± 2.1 (range 0–10) for knowledge, and 34.2 ± 6.8 (range 9–45) for attitudes, corresponding overall to moderate awareness, moderate knowledge, and moderate-to-high attitudes.

Based on the observed effect sizes and contextual understanding, the following recommendations are proposed:

1. **Experience-Informed Training Programs**: Telemedicine education should leverage the clinical expertise of experienced physicians while addressing specific knowledge gaps among older practitioners and those in underserved rural areas. Training should emphasize practical clinical applications rather than theoretical knowledge alone.
2. **Targeted Infrastructure Investment**: Substantial geographical disparities should be addressed through strategic investments in digital infrastructure, particularly reliable internet connectivity and on-site technical support systems in digitally impoverished regions such as Toyserkan. Infrastructure planning should consider not only geographical remoteness but also historical investment patterns and socioeconomic conditions.
3. **Equity-Focused Interpretation of Small Effects**: Given the modest gender effects, interventions should prioritize equitable access to digital training education and opportunities rather than gender-specific interventions. Future qualitative research should explore sociocultural and educational factors underlying observed gender differences.
4. **Regional Development Strategies**: Implementation plans should be context-specific, accounting for substantial regional variations, with particular

attention to addressing the complex factors contributing to performance challenges in Toyserkan.

Future Research Directions

Future investigations should include longitudinal designs to track telemedicine adoption trajectories over time, intervention studies evaluating implementation strategies, and qualitative inquiries examining organizational, technological, and psychological factors influencing telemedicine integration. Particular attention should be given to understanding how clinical experience translates into telemedicine competency and how geographical factors interact with infrastructure development to shape adoption outcomes.

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Availability of Data and Materials

All data generated or analyzed during this study are included within this published article.

Competing Interests

The authors declare no conflict of interests.

Consent for Publication

Not applicable.

Ethical Approval

The current study was conducted according to the Declaration of Helsinki and approved by the Ethics Committee of the Hamadan University of Medical Sciences (approval number: IR.UMSHA.REC.1395.233). Verbal informed consent was obtained from all participants.

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