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Research and Applications

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Telemedicine appointments are more likely to be completed than in-person healthcare appointments: a retrospective cohort study

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Abstract

Objectives: Missed appointments can lead to treatment delays and adverse outcomes. Telemedicine may improve appointment completion because it addresses barriers to in-person visits, such as childcare and transportation. This study compared appointment completion for appointments using telemedicine versus in-person care in a large cohort of patients at an urban academic health sciences center.

Materials and Methods: We conducted a retrospective cohort study of electronic health record data to determine whether telemedicine appointments have higher odds of completion compared to in-person care appointments, January 1, 2021, and April 30, 2023. The data were obtained from the University of South Florida (USF), a large academic health sciences center serving Tampa, FL, and surrounding communities. We implemented 1:1 propensity score matching based on age, gender, race, visit type, and Charlson Comorbidity Index (CCI).

Results: The matched cohort included 87 376 appointments, with diverse patient demographics. The percentage of completed telemedicine appointments exceeded that of completed in-person care appointments by 9.2 points (73.4% vs 64.2%, $P < .001$). The adjusted odds ratio for telemedicine versus in-person care in relation to appointment completion was 1.64 (95% CI, 1.59-1.69, $P < .001$), indicating that telemedicine appointments are associated with 64% higher odds of completion than in-person care appointments when controlling for other factors.

Discussion: This cohort study indicated that telemedicine appointments are more likely to be completed than in-person care appointments, regardless of demographics, comorbidity, payment type, or distance.

Conclusion: Telemedicine appointments are more likely to be completed than in-person healthcare appointments.

Lay Summary

Missed healthcare appointments can lead to treatment delays and poor health outcomes. Telemedicine may improve appointment completion because it addresses barriers to in-person visits, such as a lack of childcare and transportation. This study compared appointment completion for appointments using telemedicine versus in-person care in a large group of patients at an urban academic health sciences center. We conducted a retrospective cohort study of electronic health record data to determine whether telemedicine appointments have higher odds of completion compared to in-person care appointments, January 1, 2021, and April 30, 2023. The data were obtained from the University of South Florida (USF), a large academic health sciences center serving Tampa, FL, and surrounding communities. We used propensity score matching to reduce potential bias. The sample included 87 376 appointments, with diverse patient demographics. The percentage of completed telemedicine appointments exceeded that of completed in-person care appointments by 9.2 points (73.4% vs 64.2%, $P < .001$). We found that telemedicine appointments are associated with 64% higher odds of completion than in-person care appointments when controlling for other factors. This cohort study indicated that telemedicine appointments are more likely to be completed than in-person care appointments.

Key words: telemedicine; missed appointments; appointments and schedules; digital health; data science; informatics.

Introduction

Missed appointments are a longstanding and common problem in healthcare delivery. When appointments are scheduled but not attended, quality of care is adversely affected. Missed appointments can lead to downstream events and outcomes, including treatment delays, costly emergency department visits, poorer outcomes, and a higher risk of death.[1] In England, the rate of missed mental health appointments has been

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estimated at 19.1%, nearly 1 out of every 5 appointments, and is associated with subsequent treatment drop-out and other adverse outcomes that include relapse, re-admission, and completed suicide.[2] Additionally, the wasted space, equipment, and personnel resources adversely affect the healthcare system.[3–5] Researchers have estimated the cost of missed appointments in diverse settings, with annual clinic-level costs of millions of U.S. dollars.[3–5]

Patients miss appointments for a variety of reasons. Missed appointments have been attributed to socioeconomic factors, emotional factors such as fear and avoidance, demographics, family stability, a lack of awareness about the reason for an appointment, and incompatibility of appointment time.[6,7] Among urban, low-income patients, patients may need more affordable and reliable transportation and miss appointments due to family and work commitments or poor health.[8] In effect, economically disadvantaged patients may feel unwell to travel to an appointment, unable to pay for the appointment, constrained by childcare responsibilities, unable to adjust their work schedule, or fear the appointment. They may also dislike the provider or not feel like going. Healthcare systems and providers also miss appointments due to scheduling mistakes, emergencies, staffing, or other reasons.[9] The reasons for missed appointments are complex and multifactorial. Reminder systems such as phone calls and short message service (SMS) messages that address appointment awareness, some augmented with artificial intelligence, show some marginal benefit in mitigating missed appointments.[10,11] However, missed appointments largely persist. This suggests that factors other than appointment awareness more strongly influence appointment completion.

One potentially important strategy for improving appointment completion is telemedicine, which appears to address common barriers to obtaining healthcare, including lack of transportation or childcare and conflicts with work or personal commitments.[12–14] Telemedicine also addresses barriers posed by a lack of access to local healthcare providers, disasters, and environmental hazards such as extreme heat or poor air quality that are linked to climate change.[15–19] However, we need to better understand the effect of telemedicine on appointment completion to optimize its use within care delivery models and to inform policy governing its use and reimbursement.[20,21]

Objective

This study aimed to compare overall rates and characteristics of appointment completion between appointments conducted using telemedicine versus in-person care in a large, cohort of patients at an urban academic health sciences center.

Methods

In this retrospective cohort study of electronic health record (EHR) data, we examined whether telemedicine appointments had a higher completion rate than in-person care appointments between January 1, 2021, and April 30, 2023. Furthermore, we examined the crude and adjusted odds of appointment completion using multivariate Generalized Linear Models (GLM). The University of South Florida (USF) Institutional Review Board reviewed and approved the study (USF IRB STUDY005197).

Setting, data, and sample

Data were obtained from EHRs of USF patients who received medical care between January 1, 2021, and April 30, 2023. USF is a large academic health sciences center serving Tampa, FL, and surrounding communities. Tampa, FL, has a racially and ethnically diverse population.[22] USF offers inpatient and outpatient services across numerous medical specialties, serving approximately 1.2 million patients.

Through preliminary analyses, we identified specialties and visit types offered using both in-person care and telemedicine. We used the visit type field in the EHR to identify telemedicine visits. In the study setting, visits with "telemedicine" or "telehealth" in the visit type description are telemedicine visits. We limited encounters to USF visit types with equivalent labels for both in-person care and telemedicine. Furthermore, to mitigate potential bias related to the multiplicate presence of individual patients, we limited the sample to one appointment per patient, including the first occurrence associated with a unique patient during the study dates. Then, we categorized visit types as new patient visits (NPV) or established patient visit types (EPV). A summary of inclusion and exclusion criteria for appointments follows.

The inclusion criteria for appointments were as follows: (1) appointment scheduled between January 1, 2021, and April 30, 2023; (2) appointment with visit type actively used for both telemedicine and standard (in-person) care; and (3) appointment is the first appointment associated with a unique patient during the study time period. The exclusion criteria for the study were as follows: (1) appointment visit type not actively used for both telemedicine or standard (in-person) care, and (2) telephone-only appointments. We focused the analysis on each patient's first visit during the study window to reduce imbalances related to the heterogeneity in the number of visits per patient in both cohorts and to keep the cohorts as similar as possible.

We defined missed appointments as appointments that were canceled, no show, or left without being seen. "Cancellation" indicated an appointment was canceled in advance of the appointment date/time, without re-scheduling. "No show" indicated appointments that were not canceled in advance, and not attended by the patient. "Left without being seen" appointments indicated that the patient checked in, connected to the call, or arrived at a previously scheduled appointment, and exited before being seen by a provider. We calculated the Charlson Comorbidity Index (CCI) for each patient as a general indicator of patient health, which could potentially influence appointment completion.[23] Travel distance was the distance in miles between a patient's ZIP code and the ZIP code of the clinic for which the appointment was made.

Analysis

All statistical analyses were performed using R version 4.3.0. Differences between the telemedicine and in-person care groups were assessed using independent sample t-tests, for continuous variables, and Chi-square tests, for categorical variables. Because the in-person care group was significantly larger than the telemedicine group, we matched the 2 groups based on 1:1 propensity score matching using the K-nearest neighbor method, implemented using the MatchIt package.[24] We matched on age, gender, race, visit type, and CCI. Travel distance was calculated using the zipcodeR package.[25] To calculate the adjusted odds ratios, we developed a GLM model[26] of visit completion with the following variables as inputs: appointment modality (ie, telemedicine vs in-person care), age, gender, race, CCI, and the variables that remained unbalanced after matching. Visit completion was constructed as a binary variable where 1 indicated a visit with a "Complete" status and 0 indicated a visit with a "Canceled," "Left without seen," or "No show" status. We used maximum likelihood as the estimation method and assumed a binomial probability distribution.

Results

A total of 236 502 appointments corresponded to visit types available as both telemedicine and in-person care at the USF between January 1, 2021, and April 30, 2023. The characteristics of the baseline cohort are described in Tables 1 and 2. Overall, 62.6% (148 054) appointments were completed and 37.4% (86 439) were missed appointments (cancelled, no-show, or left without being seen). The specialties with the highest number and percentage of telemedicine visits included Internal Medicine (18 881, 8%), Neurology (18 656, 7.9%), Neurosurgery (19 180, 8.1%), and Obstetrics & Gynecology (20 574, 8.7%). After applying inclusion and exclusion criteria, then implementing propensity score matching, 87 376 appointments remained eligible for the study (see matched cohort, Table 1). After matching, statistically significant differences were identified in patient ethnicity, insurance type, and travel distance between the telemedicine and in-person care groups.

Results for telemedicine versus in-person care

Figure 1 depicts the distribution of appointment status outcomes within the in-person care and telemedicine groups. In the matched cohort, the percentage of completed telemedicine appointments exceeded that of completed in-person care appointments by 9.2 points (73.4% vs 64.2%, $P < .001$). Within the not completed appointments, canceled appointments occurred less frequently in the telemedicine group than in the in-person care group (21.3% vs 29.2%, $P < .001$) and no-show appointments occurred less frequently in the telemedicine group than in the in-person care group (5.2% vs 6.6%).

The unadjusted odds ratio for appointment completion with telemedicine versus in-person care appointments was 1.54 (95% CI, 1.50-1.59, $P < .001$), as seen in Table 3. The multivariate model of appointment completion resulted in a Hosmer-Lemeshow Chi-squared 723, $\text{df} = 8$, $P < .001$. Multiple variables reached statistical significance as predictors of appointment completion including age, gender, race, ethnicity, insurance type, visit type, and comorbidities (see Table 4). Upon adjustment, the odds ratio for telemedicine versus in-person care in relation to appointment completion was 1.64 (95% CI, 1.59-1.69, $P < .001$), indicating that telemedicine appointments were associated with 64% higher odds of completion than in-person care appointments when controlling for other factors. We created an additional multivariate model incorporating specialty as a covariate, detailed in Supplementary Material, Appendix A. In this model, the adjusted odds ratio for telemedicine versus in-person care was 1.71 (95% CI, 1.65-1.77, $P < .001$).

Discussion

This large cohort study compared the effect of telemedicine versus in-person care upon outpatient appointment completion across diverse specialties within an academic health sciences center. We found that telemedicine appointments are associated with a 64% increase in the odds of completion and are less likely to result in cancellations or no-shows after adjusting for demographics, payment type, comorbidity, and distance. These findings suggest that telemedicine appointments are more likely to be completed than in-person care appointments. Additional factors may also influence appointment completion and should be considered in efforts to implement telemedicine and optimize healthcare access for a community.

Completing scheduled healthcare appointments is fundamental to quality care delivery and continuity of care. Missed appointments, whether initial or follow-up visits, may diminish continuity of care for an individual, adversely affecting patient outcomes.[27] For patients with a history of missed appointments and those receiving mental healthcare, particularly those at risk of suicide, the availability of telemedicine may be critical for accomplishing care and mitigating adverse outcomes.[2] It may be equally important for any patient experiencing barriers such as transportation, childcare responsibilities, or conflicts with work. A break in care continuity may be especially consequential when patient outcomes depend on close monitoring or specific timing of treatments. Additionally, missed preventative care appointments could impact both individual and public health outcomes.[28] Conversely, appointment completion may foster subsequent adherence. In a 2017 study, initial appointment completion for patients with HIV was associated with an increased rate of overall visits attended and fewer gaps in care.[27]

To deliver high-quality care, we must find solutions that address the underlying reasons for missed appointments. Currently, common strategies to prevent "no-shows" include telephone and SMS reminders, patient portal messages, and overbooking.[29] While simple appointment reminders can counteract forgetfulness, there is a need to address other, more complex factors, including transportation and socioeconomic difficulties affecting an individual's ability to adhere to an appointment.[28] Our findings indicate that the availability of telemedicine services could be an important strategy for preventing "no-shows" and improving appointment completion in the post-pandemic era. However, current evidence suggests that telemedicine is more satisfying and accessible for some patients than others.[15,30–32] In-person care appointments may be more appropriate for patients who indicate they do not have access to appropriate telemedicine technology, are uncomfortable with telemedicine, or simply prefer in-person care appointments.

We know that system-related factors, patient-related factors, socioeconomic characteristics, and the nature of medical care all influence patient preferences related to telemedicine versus in-person care.[33] Brief assessment of these factors may enable better scheduling decisions where options exist for either telemedicine or in-person care appointments. If offered the option of telemedicine versus in-person care, patients can choose the modality that best supports their ability to attend the appointment. After initial scheduling, the capability to adapt the appointment type to the patient's current circumstances may also support appointment completion.

Table 1. Patient and appointment characteristics, baseline, and matched cohorts.

Variable	Baseline cohort				Matched cohort			
	In-person care (N = 182 665)	Telemedicine (N = 53 837)	All (N = 236 502)	*P*	In-person care (N = 43 688)	Telemedicine (N = 43 688)	All (N = 87 376)	*P*
Age								
Mean (SD)	52.0 (19.3)	44.4 (20.1)	50.3 (19.7)	<.001	45.9 (19.9)	45.9 (19.9)	45.9 (19.9)	.60
Median [min, max]	54.0 [18.0, 122]	42.0 [18.0, 121]	52.0 [18.0, 122]		44.0 [18.0, 101]	44.0 [18.0, 104]	44.0 [18.0, 104]	
Gender								
Female	107 308 (58.8%)	33 650 (62.5%)	140 958 (59.6%)	<.001	27 515 (63.0%)	27 652 (63.3%)	55 167 (63.1%)	.33
Male	75 326 (41.2%)	20 172 (37.5%)	95 498 (40.4%)		16 173 (37.0%)	16 036 (36.7%)	32 209 (36.9%)	
Missing	31 (0.0%)	15 (0.0%)	46 (0.0%)		–	–		
Race								
Black or African American	22 374 (12.5%)	5886 (11.0%)	28 260 (12.2%)	<.001	4828 (11.1%)	4881 (11.2%)	9709 (11.1%)	.85
Other/Unknown	37 248 (20.8%)	10 646 (20.0%)	47 894 (20.6%)		6828 (15.6%)	6827 (15.6%)	13 655 (15.6%)	
White or Caucasian	119 151 (66.6%)	36 814 (69.0%)	155 965 (67.2%)		32 032 (73.3%)	31 980 (73.2%)	64 012 (73.3%)	
Missing	3892 (2.1%)	491 (0.9%)	4383 (1.9%)		–	–		
Ethnicity								
Hispanic or Latino	30 954 (18.4%)	8547 (17.0%)	39 501 (18.1%)	<.001	7900 (18.1%)	7157 (16.4%)	15 057 (17.2%)	<.001
Not Hispanic or Latino	136 957 (81.6%)	41 670 (83.0%)	178 627 (81.9%)		35 788 (81.9%)	36 531 (83.6%)	72 319 (82.8%)	
Missing	14 754 (8.1%)	3620 (6.7%)	18 374 (7.8%)		–	–		
Visit type								
Established patient	66 850 (36.6%)	30 931 (57.5%)	97 781 (41.3%)	<.001	26 571 (60.8%)	26 621 (60.9%)	53 192 (60.9%)	.72
New patient	115 815 (63.4%)	22 906 (42.5%)	138 721 (58.7%)		17 117 (39.2%)	17 067 (39.1%)	34 184 (39.1%)	
Insurance type								
Medicaid	14 869 (9.0%)	5046 (10.7%)	19 915 (9.4%)	<.001	4560 (10.4%)	4618 (10.6%)	9178 (10.5%)	<.001
Medicare	54 417 (33.0%)	12 382 (26.2%)	66 799 (31.5%)		10 588 (24.2%)	11 466 (26.2%)	22 054 (25.2%)	
Other	4377 (2.7%)	1550 (3.3%)	5927 (2.8%)		1377 (3.2%)	1450 (3.3%)	2827 (3.2%)	
Private	91 284 (55.3%)	28 255 (59.8%)	119 539 (56.3%)		27 163 (62.2%)	26 154 (59.9%)	53 317 (61.0%)	
Missing	17 718 (9.7%)	6604 (12.3%)	24 322 (10.3%)		–	–		
Travel distance								
Mean (SD)	36.1 (132)	54.4 (176)	40.2 (143)	<.001	39.3 (145)	49.3 (163)	44.3 (154)	<.001
Median [min, max]	14.9 [0, 4780]	16.6 [0, 5240]	15.1 [0, 5240]		14.3 [0, 4780]	15.7 [0, 5240]	15.1 [0, 5240]	
Missing	2671 (1.5%)	736 (1.4%)	3407 (1.4%)		–	–		
Cancellation types								
Canceled	59 402 (32.5%)	12 252 (22.8%)	71 654 (30.3%)	<.001	12 777 (29.2%)	9318 (21.3%)	22 095 (25.3%)	<.001
Left without being seen	22 (0.0%)	42 (0.1%)	64 (0.0%)		2 (0.0%)	34 (0.1%)	36 (0.0%)	
No show	13 610 (7.5%)	3111 (5.8%)	16 721 (7.1%)		2874 (6.6%)	2262 (5.2%)	5136 (5.9%)	

Table 2. Appointment specialty, baseline and matched cohorts.

Specialty	In-person care (N = 182 665)	Telemedicine (N = 53 837)	All (N = 236 502)	*P*	In-person care (N = 43 688)	Telemedicine (N = 43 688)	All (N = 87 376)	*P*
Adolescent Medicine	688 (0.4%)	86 (0.2%)	774 (0.3%)	<.001	115 (0.3%)	77 (0.2%)	192 (0.2%)	<.001
Allergy	770 (0.4%)	95 (0.2%)	865 (0.4%)		230 (0.5%)	89 (0.2%)	319 (0.4%)	
Audiology	1273 (0.7%)	28 (0.1%)	1301 (0.6%)		208 (0.5%)	3 (0.0%)	211 (0.2%)	
Cardiology	17 492 (9.6%)	4587 (8.5%)	22 079 (9.3%)		3537 (8.1%)	4098 (9.4%)	7635 (8.7%)	
Cardiothoracic Surgery	405 (0.2%)	54 (0.1%)	459 (0.2%)		119 (0.3%)	47 (0.1%)	166 (0.2%)	
Colon & Rectal Surgery	3338 (1.8%)	209 (0.4%)	3547 (1.5%)		621 (1.4%)	189 (0.4%)	810 (0.9%)	
Dermatology	12 452 (6.8%)	99 (0.2%)	12 551 (5.3%)		3728 (8.5%)	82 (0.2%)	3810 (4.4%)	
Diabetes	3262 (1.8%)	1897 (3.5%)	5159 (2.2%)		1112 (2.5%)	1677 (3.8%)	2789 (3.2%)	
Endocrinology, Diabetes & Metabolism	976 (0.5%)	155 (0.3%)	1131 (0.5%)		263 (0.6%)	144 (0.3%)	407 (0.5%)	
Family Medicine	6402 (3.5%)	1813 (3.4%)	8215 (3.5%)		2232 (5.1%)	1638 (3.7%)	3870 (4.4%)	
Gastroenterology	7627 (4.2%)	1613 (3.0%)	9240 (3.9%)		1545 (3.5%)	1513 (3.5%)	3058 (3.5%)	
General Surgery	4995 (2.7%)	381 (0.7%)	5376 (2.3%)		1132 (2.6%)	343 (0.8%)	1475 (1.7%)	
Gynecology	1934 (1.1%)	1076 (2.0%)	3010 (1.3%)		665 (1.5%)	714 (1.6%)	1379 (1.6%)	
Hematology	149 (0.1%)	767 (1.4%)	916 (0.4%)		36 (0.1%)	652 (1.5%)	688 (0.8%)	
Internal Medicine	10 332 (5.7%)	8549 (15.9%)	18 881 (8.0%)		3234 (7.4%)	5508 (12.6%)	8742 (10.0%)	
Maternal & Fetal Medicine	140 (0.1%)	2157 (4.0%)	2297 (1.0%)		31 (0.1%)	1886 (4.3%)	1917 (2.2%)	
Nephrology	1051 (0.6%)	459 (0.9%)	1510 (0.6%)		232 (0.5%)	403 (0.9%)	635 (0.7%)	
Neurology	6600 (3.6%)	12 056 (22.4%)	18 656 (7.9%)		1674 (3.8%)	10 255 (23.5%)	11 929 (13.7%)	
Neuropsychology	6 (0.0%)	402 (0.7%)	408 (0.2%)		3 (0.0%)	354 (0.8%)	357 (0.4%)	
Neurosurgery	17 043 (9.3%)	2137 (4.0%)	19 180 (8.1%)		3211 (7.3%)	1682 (3.9%)	4893 (5.6%)	
Obstetrics & Gynecology	19 132 (10.5%)	1442 (2.7%)	20 574 (8.7%)		5486 (12.6%)	1317 (3.0%)	6803 (7.8%)	
Ophthalmology	14 449 (7.9%)	7 (0.0%)	14 456 (6.1%)		2665 (6.1%)	5 (0.0%)	2670 (3.1%)	
Orthopedic Surgery	2619 (1.4%)	642 (1.2%)	3261 (1.4%)		666 (1.5%)	439 (1.0%)	1105 (1.3%)	
Otorhinolaryngology	11 899 (6.5%)	663 (1.2%)	12 562 (5.3%)		2461 (5.6%)	565 (1.3%)	3026 (3.5%)	
Pediatric Allergy & Immunology	607 (0.3%)	189 (0.4%)	796 (0.3%)		213 (0.5%)	158 (0.4%)	371 (0.4%)	
Pediatric Gastroenterology	69 (0.0%)	4 (0.0%)	73 (0.0%)		26 (0.1%)	4 (0.0%)	30 (0.0%)	
Pediatric Genetics	190 (0.1%)	369 (0.7%)	559 (0.2%)		57 (0.1%)	273 (0.6%)	330 (0.4%)	
Pediatric Hematology-Oncology	109 (0.1%)	9 (0.0%)	118 (0.0%)		61 (0.1%)	9 (0.0%)	70 (0.1%)	
Pediatric Infectious Diseases	611 (0.3%)	30 (0.1%)	641 (0.3%)		150 (0.3%)	26 (0.1%)	176 (0.2%)	
Pediatric Nephrology	612 (0.3%)	21 (0.0%)	633 (0.3%)		346 (0.8%)	19 (0.0%)	365 (0.4%)	
Pediatric Neurology	108 (0.1%)	94 (0.2%)	202 (0.1%)		38 (0.1%)	81 (0.2%)	119 (0.1%)	
Pediatric Psychiatry	2 (0.0%)	71 (0.1%)	73 (0.0%)					
Pediatric Pulmonology	94 (0.1%)	19 (0.0%)	113 (0.0%)		58 (0.1%)	17 (0.0%)	75 (0.1%)	
Pediatrics	3704 (2.0%)	1572 (2.9%)	5276 (2.2%)		1238 (2.8%)	1419 (3.2%)	2657 (3.0%)	
Physical Therapy	1247 (0.7%)	6 (0.0%)	1253 (0.5%)		488 (1.1%)	5 (0.0%)	493 (0.6%)	
Plastic Surgery	3836 (2.1%)	146 (0.3%)	3982 (1.7%)		873 (2.0%)	127 (0.3%)	1000 (1.1%)	
Psychiatry	2269 (1.2%)	4836 (9.0%)	7105 (3.0%)		388 (0.9%)	3576 (8.2%)	3964 (4.5%)	
Psychology	2 (0.0%)	6 (0.0%)	8 (0.0%)		1 (0.0%)	5 (0.0%)	6 (0.0%)	
Pulmonary Disease	2741 (1.5%)	345 (0.6%)	3086 (1.3%)		630 (1.4%)	315 (0.7%)	945 (1.1%)	
Rheumatology	4100 (2.2%)	556 (1.0%)	4656 (2.0%)		886 (2.0%)	520 (1.2%)	1406 (1.6%)	
Speech Pathology	40 (0.0%)	32 (0.1%)	72 (0.0%)		10 (0.0%)	18 (0.0%)	28 (0.0%)	
Sports Medicine	116 (0.1%)	304 (0.6%)	420 (0.2%)		86 (0.2%)	223 (0.5%)	309 (0.4%)	
Urgent Care	656 (0.4%)	117 (0.2%)	773 (0.3%)		254 (0.6%)	65 (0.1%)	319 (0.4%)	
Urology	11 916 (6.5%)	3493 (6.5%)	15 409 (6.5%)		1855 (4.2%)	2932 (6.7%)	4787 (5.5%)	
Vascular Surgery	4602 (2.5%)	244 (0.5%)	4846 (2.0%)		824 (1.9%)	216 (0.5%)	1040 (1.2%)	

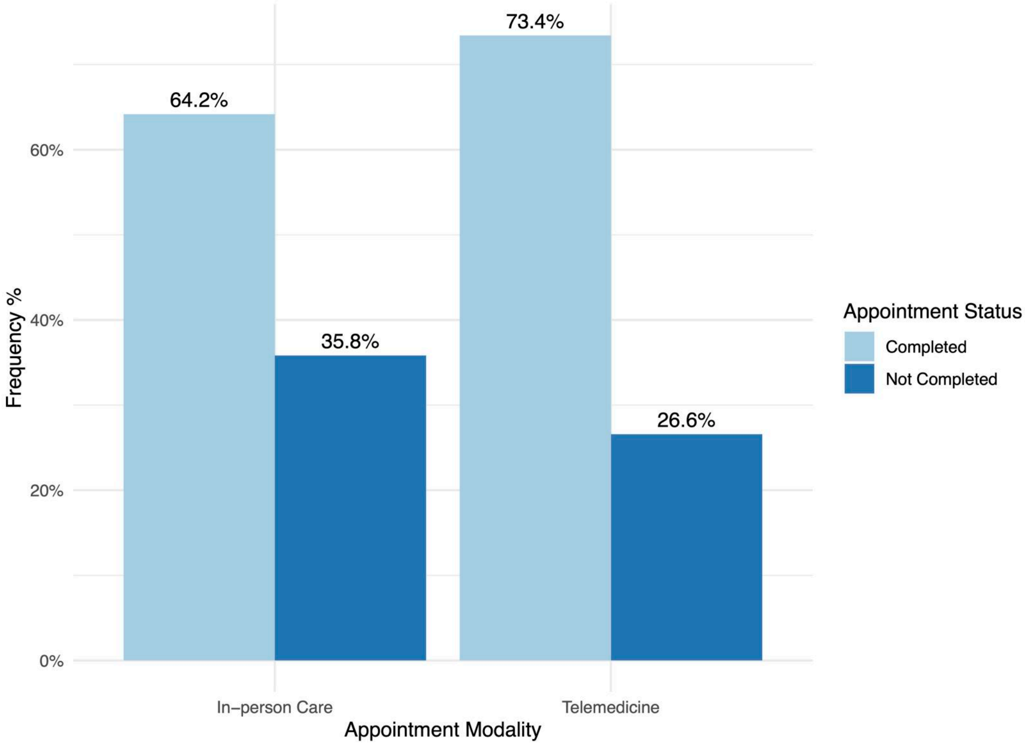

Figure 1. Distribution of appointment completion outcomes for telemedicine and standard (in-person) care (matched cohort).

Table 3. Univariate model, effect of telemedicine on appointment completion (N = 104 698).

Predictors	Odds ratio	95% confidence intervals	*P*
(Intercept)	1.79	1.76-1.83	<.001
Telemedicine	1.54	1.50-1.59	<.001
Observations	87 376		
R2 Tjur[a]	0.01		

[a] Tjur's R2 coefficient of determination.

When in-person care appointments are necessary and preferred, planning to address barriers such as transportation and childcare may be helpful in promoting appointment completion.

Limitations

This study included a large and diverse population but also reflects the system, provider, and patient characteristics of a single academic healthcare system in the southeastern Unites States. Patterns of appointment completion with telemedicine could differ with local or regional variation in the quality and stability of telemedicine services, the travel distance of patients from healthcare facilities, policy governing reimbursement for telemedicine services, access to appropriate devices, internet connection quality, and preferences for obtaining care via telemedicine and in-person. We limited this study to first telemedicine visits and appointment completion may have differed for subsequent appointments, given increased telemedicine familiarity. We did not consider individual providers as a confounding variable. We note that this was a large-scale, EHR-based study, and individual provider and clinic documentation practices in classifying missed appointment outcomes may have varied. Additionally, we did not include telephone-only appointments in the analysis. However, telemedicine appointments may have taken place via telephone-only if patient or provider experience difficulties with their connection. Additionally, while telemedicine was associated with higher odds of appointment completion overall, there could be differences among population subgroups with different perspectives and barriers related to healthcare services. We plan to explore these nuances in future mixed-methods research. While the completion of a scheduled healthcare appointment is desirable, and

Table 4. Multivariate model, effect of telemedicine on appointment completion (N = 104 698).

Predictors	Odds ratio	95% confidence intervals	*P*
(Intercept)	9.74	9.06-10.48	<.001
Telemedicine	1.64	1.59-1.69	<.001
Age	0.95	0.94-0.95	<.001
Gender [Male]	0.93	0.90-0.96	<.001
Race [ref: White/Caucasian]			
Black or African American	0.84	0.80-0.88	<.001
Other/Unknown	0.95	0.91-1.00	.041
Ethnicity [Not Hispanic/Latino]	1.11	1.07-1.16	<.001
Insurance Type [ref: Private]			
Medicaid	0.55	0.53-0.58	<.001
Medicare	0.49	0.47-0.52	<.001
Other	0.98	0.90-1.07	.625
Visit type [Established patient]	0.94	0.91-0.97	<.001
Travel distance	1	1.00-1.00	.751
Charlson Comorbidity Index	2.47	2.42-2.53	<.001
Observations	87 376		
R2 Tjur[a]	0.112		

[a] Tjur's R2 coefficient of determination.

appointment completion has found to be associated with better overall health outcomes, there are numerous individual-, system-, and treatment-related factors that contribute to health commons. Certainly, when telemedicine is inappropriate given a patient's healthcare needs, quality could be diminished, and additional healthcare resources may be needed for appropriate care.[34]

Conclusions

This retrospective cohort study conducted at a large academic health sciences center indicates that telemedicine appointments are more likely to be completed than in-person care appointments, regardless of demographics, comorbidity, payment type, or distance. Telemedicine appointments are more likely to be completed, potentially enhancing quality of care and avoiding adverse outcomes, including missed or delayed care, emergency department visits, poor clinical outcomes, and wasted resources. However, there is a need to consider patient preferences and barriers when selecting an appropriate modality for care delivery, whether in-person care or telemedicine, and these should be assessed to optimize scheduling. Given this finding, telemedicine services should be considered a key strategy in improving care quality and mitigating the adverse effects of missed appointments. Future research should more closely examine the experience and outcomes of telemedicine care delivery within specific clinical sub-populations and geographically diverse settings.

Author contributions

Mollie R. Cummins, Athanasios Tsalatsanis, and Brian E. Bunnell conceived and designed the study, developed the protocol, and obtained ethical approval. Athanasios Tsalatsanis and Chaitanya Chaphalkar conducted the statistical analysis. Julia Ivanova, Triton Ong, Hiral Soni, Janelle F. Barrera, Hattie Wilczewski, and Brandon M. Welch contributed to the literature search and interpretation of findings. Mollie R. Cummins wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

Supplementary material

Supplementary material is available at *JAMIA Open* online.

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Conflicts of interest

B.M.W. is a shareholder, and M.R.C., J.I., T.O., H.S., J.F.B., H.W., and B.E.B. are employees of Doxy.me Inc., a commercial telemedicine company. The authors declare no other competing interests.

Data availability

This study entailed analysis of electronic health record data. Due to the nature of the research, and relevant ethical and legal considerations, supporting data are not available.

Ethical approval and consent to participate

The Institutional Review Board of the University of South Florida approved this study as exempt human subjects research (STUDY005197). Consistent with this determination, we did not obtain individual consent to participate.

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