ORIGINAL RESEARCH

Self-Reported Nonadherence Associated with Pharmacy and Home Medication Management Inconvenience Factors in a US Adult Population

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Purpose: Medication nonadherence is a significant and multidimensional problem contributing to an increased risk of morbidity and mortality. Inconveniences in pharmacy and home contexts may increase nonadherence. This research examined inconveniences in pharmacy and home contexts associated with self-reported nonadherence, controlling for demographic and medication-taking covariates.

Methods: Data from 4682 individuals who reported self-managing medications in an online marketing survey between October and December 2017 were analyzed in this secondary analysis. Nonadherence was dichotomized using a single question about likelihood to take medications as prescribed (adherence=always; nonadherence=most of the time, some of the time, never). Multivariable logistic regression with backwards elimination was used to examine the pharmacy (use of home delivery, number prescriptions picked up and visits to pharmacy) and home context (method used to organize/manage medications, satisfaction, and bother with management) variables and the demographic (age, sex, race/ethnicity, education, income, insurance) and medication (number of oral medications, medication changes and frequency of taking) covariates associated with nonadherence.

Results: Overall, 25.8% of the responses indicated nonadherence. Nonadherence was more likely for individuals making fewer separate pharmacy trips (OR 0.98; 95% CI 0.97–0.99); picking up fewer prescriptions (OR 0.96; 95% CI 0.93–0.99); never, rarely or sometimes using mail order compared with always (OR 1.71; 95% CI 1.30–2.26); not satisfied with managing medications (OR 2.13; 95% CI 1.42–3.19); and using pill pouches and being bothered by them (OR 8.28; 95% CI 1.83–37.31). Using pill pouches or a pillbox and not being bothered by them significantly decreased nonadherence likelihood. Younger and female respondents and those reporting medication changes in the last year were also more likely to report nonadherence.
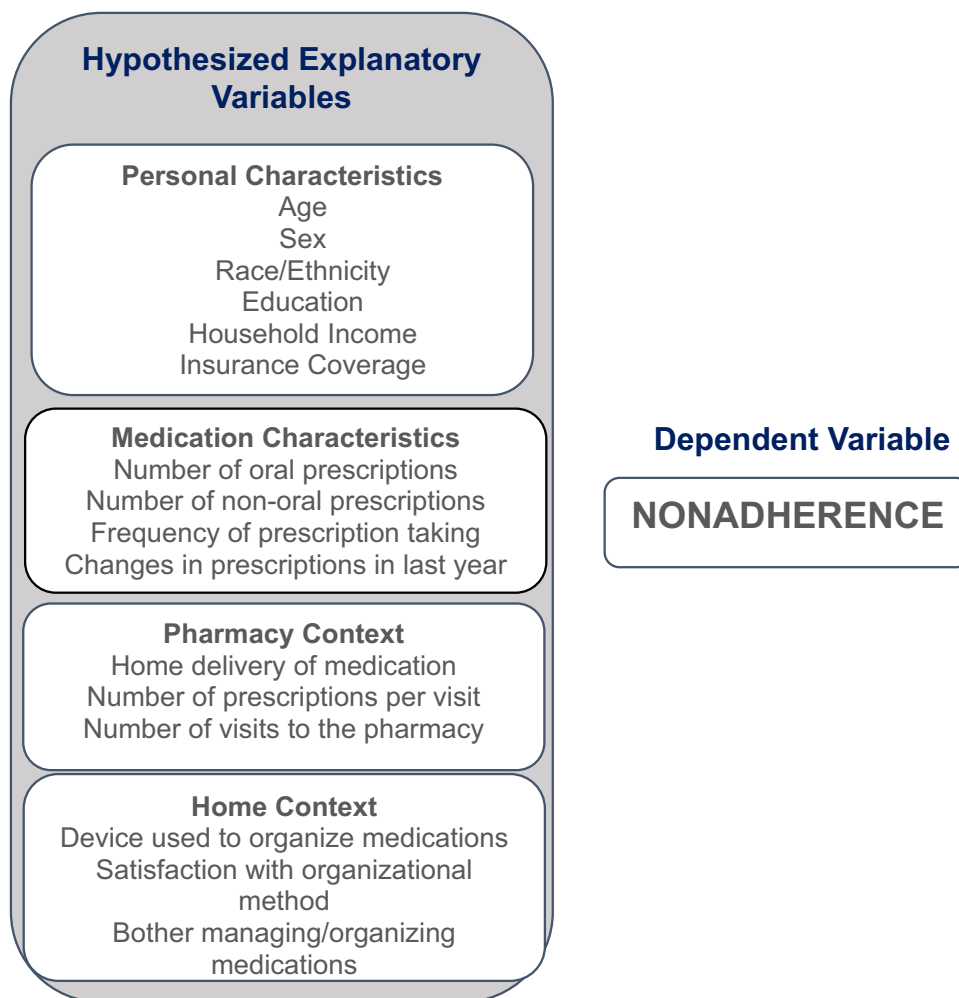
Conclusion: Though reasons for nonadherence are multidimensional, this study suggests that inconveniences in both the pharmacy and home context are important. Improving adherence requires addressing issues of inconvenience across the care continuum.

Keywords: medication adherence, medication compliance, community pharmaceutic services, outpatient, drug packaging, behavior and behavior mechanisms, MeSH

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Introduction

Approximately 75% of all interactions with healthcare facilities involve drug therapy,[1] yet an estimated one out of three Americans do not take their medications as prescribed,[2] known as nonadherence. Nonadherence can result from not initiating treatment, poor implementation (eg, missing or skipping doses), and early discontinuation of therapy.[3]

**Hypothesized Explanatory
Variables**

Personal Characteristics
Age
Sex
Race/Ethnicity
Education
Household Income
Insurance Coverage

Medication Characteristics
Number of oral prescriptions
Number of non-oral prescriptions
Frequency of prescription taking
Changes in prescriptions in last year

Pharmacy Context
Home delivery of medication
Number of prescriptions per visit
Number of visits to the pharmacy

Home Context
Device used to organize medications
Satisfaction with organizational
method
Bother managing/organizing
medications

Dependent Variable

NONADHERENCE

Figure 1 Context-specific variables likely associated with nonadherence.

Nonadherence increases the risk of hospitalization, morbidity, and premature mortality[4] and contributes to an estimated $290 billion annually in avoidable health system costs.[2,5] Due to associated high costs and morbidity, researchers and healthcare providers should consider ways in which they can make managing and adhering to prescribed medications more convenient for patients.

Much of the adherence research to date has been disease-, population- or medication-specific, identifying a wide variety of factors impacting nonadherence: More than 200 factors have been attributed to nonadherence.[2] Evidence from systematic and meta-analytic reviews reflect that across studies predictors do not reliably produce the same results and in some cases conflict with one another.[6–8] The World Health Organization's framework for medication nonadherence reflects that nonadherence is multidimensional,[2] yet studies often focus on only one dimension of nonadherence and little attention has focused on the interrelationships of contexts that represent the patients' continuum of accessing and managing medications.[9] The pharmacy and home management contexts are key parts of the adherence continuum.[10] In the pharmacy context, convenience factors such as willingness to wait in line for prescriptions[11] and use of mail order pharmacies to obtain prescriptions may impact patient adherence. In the context of home management, people are tasked with creating routines, preparing correct dosing, using prompts, and self-monitoring to maintain adherence. As such, people use a variety of methods to organize medications such as the original packaging from the pharmacy, pillbox organizers, and other types of convenience packaging devices.[12] Packaging device effectiveness[13] is likely related to how satisfied patients are with the device. These multidimensional aspects of managing and organizing medications in pharmacy and home contexts are likely to affect nonadherence. A better understanding of

how these factors impact nonadherence is important for designing interventions to support adherence across the care continuum.

The purpose of this study was to examine relationships between aspects of pharmacy and home medication management and self-reported medication nonadherence, controlling for demographic and medication-taking variables. In this study, the aspects of interest represent conveniences and inconveniences in the medication management process in the pharmacy and home contexts. For the purpose of this study, inconvenience refers to situational aspects that: 1) increase steps or add complexity in acquiring medication, or 2) add processes or complications associated with managing and administering medication. Approaches to addressing inconvenience include, but are not limited to, reducing or eliminating trips to the pharmacy and simplifying methods of organizing and tracking medication. Understanding these pharmacy and home medication management aspects will provide important new context-specific information that reflects the continuum of individuals' medication management. We believe this will be important for future work to develop interventions that target both the pharmacy and home contexts.

Methods
This secondary analysis used existing survey data that was originally collected between October and December 2017. The dataset used for this secondary analysis was deidentified and therefore did not meet the definition of human subjects research[14] as determined by the Indiana University Institutional Review Board [Review Number 2001947912].

Participants
The original survey data were collected for market research purposes to understand adults' experiences using pharmacies and managing medications. Participants were recruited by email invitation sent to online panels and a multi-sourced opt-in panel recruited using e-mail recruitment, affiliate networks, and website advertising using the KnowledgePanel® (Ipsos, Ltd).[15–17] Eligible respondents were adults (18 years and older) who had visited a pharmacy at least twice in the past 6 months, with at least one visit having taken place within the past month. Respondents had at least some involvement in the selection of pharmacy location, either making the decision themselves or together with someone else. Additionally, respondents must have been prescribed at least one daily prescription. The original survey data were collected

online after screening eligibility was determined based on survey responses and individuals indicated that they agreed to participate as a response option. The time to complete the full online survey was approximately 30 mins and respondents received $5 in compensation at completion. This secondary analysis is restricted to participants who independently managed their own medications and responded to one survey question asking about medication taking that was used to establish adherence status in this study, as further described below.

Procedures
Selection of variables representing aspects of medication management and organization in pharmacy and home contexts was based on the available survey data, prior literature, and guided by the Medication Adherence Contexts and Outcomes (MACO) Framework.[10,18] The MACO framework posits that outcomes of medication adherence and medication nonadherence result from processes that occur within distinct yet interrelated contexts. These contexts include clinic encounters, pharmacy encounters, and day-to-day home management and underlie the continuum of an individual's medication management. For the purposes of the present study, we focused on the contexts of pharmacy and day-to-day home management to select variables that we hypothesized would be associated with medication nonadherence (Figure 1).

Variables from Survey Questionnaire
Demographic and Medication Characteristics
Available data included age, sex, race, ethnicity, education, household income, number of oral prescriptions, frequency of prescription medication taking, and changes in prescribed medications in the last year. Age was reported as years on a continuous scale. The other variables were categorical. Sex was reported as male or female. Race consisted of 6 response options in which respondents could select "yes" or "no" options for each category (White, Black or African American, American Indian or Alaskan Native, Asian, Native Hawaiian or other Pacific Islander, and Other). Education was reported as the highest degree obtained with four categories (less than high school, high school, some college, and bachelor's degree or higher). This variable was also dichotomized into categories of "high school or less" and "more than high school education". Household income was comprised of five categories ($19,999 or less, $20,000–39,999, $40,000–59,999, $60,000–99,999, $100,000 or greater) and represented the

total household income earned in the prior 12 months before taxes. Number of oral prescriptions and nonoral medications taken daily were classified into three categories (one, two, and three or more). Similarly, frequency of prescription medication taking was categorized into three categories representing how many times per day medications were taken (Once a day, 2 times a day, and 3 or more times a day). Changes in prescribed medications in the past year were treated as a dichotomous variable with "yes" or "no" options.

Pharmacy Context

Data for understanding the pharmacy context were derived from three survey questions about obtaining medications from pharmacies. The first question asked how often the individual used a mail order, online, or home-delivery pharmacy service to obtain medications with response options "Always", "Some of the time", "Rarely", "Never". This question was dichotomized for analysis to compare those "always" using mail order to a separate category combining all other responses. The second question asked participants to identify the average number of individual prescriptions picked up per brick and mortar pharmacy visit and was measured on a continuous scale. The third question asked individuals to identify the number of separate trips made to a pharmacy on a monthly basis and was treated as a continuous scale variable.

Home Management Context

Data about the home context were derived from three survey questions focused on aspects of medication management that represent experiences in the home context: 1) methods used to organize medications, 2) satisfaction with organization methods, and 3) how bothered individuals are with organizing medications. Methods used to organize medications included 4 categories (original packaging/bottles, pillboxes, pill pouches and some other type of organization method). Satisfaction was a dichotomous variable in response to a question asking about respondents' overall satisfaction with the current method for managing and organizing medications at home (satisfied, not satisfied). How bothersome respondents found organizing medications was measured on a 4-point Likert-type scale with options "Not at all bothersome", "not too bothersome", "somewhat bothersome", and "very bothered". The variable used for analysis combined the options representing any level of bother ("not too bothersome", "somewhat bothersome", and "very bothered") to create a dichotomous variable

with categories "bothered by organizing medications" and "not bothered by organizing medications".

Medication Adherence Status

A single self-report question asked participants to rate in general how likely they were to take their daily oral prescribed medications and over the counter supplements prescribed by a doctor, rated on a 4-point scale ("always", "most of the time", "only some of the time", "almost never"). For the present analysis, the World Health Organization's adherence definition guided dichotomizing the response options to create the category of adherence ("always") and nonadherence ("most of the time", "only some of the time" and "almost never"). While this single-item measure of medication adherence has not been validated, it is similar to other single-item scales that have been used to screen for medication adherence.[19–21]

Data Analysis

Analyses were performed using SPSS Statistics for Windows, Version 25.0 (IBM Corp. Armonk, NY). Descriptive statistics appropriate for the measurement level (eg, frequencies and percentages for nominal/ordinal; mean and standard deviation for continuous variables) were used. Independent t-tests were used to compare the means of continuous variables and the chi-square tests were used to test differences in proportions of categorical variables between the nonadherent and adherent groups. An iterative binary logistic regression analysis approach was used to examine relationships between pharmacy and home medication management context factors and self-reported medication nonadherence, controlling for demographic and medication-taking variables. First, univariate analysis of each independent variable was performed with the selection criteria set at $p \leq 0.25$ as recommended by Hosmer, Lemeshow & Sturdivant.[22] The multivariable model containing all covariates identified by univariate analysis was fit with logistic regression analysis using the backward step likelihood ratio method. Subsequently, two-way interactions between each of the pharmacy and home management context variables (Hosmer, Lemeshow & Sturdivant, 2003) were examined and the possible two-way interaction between age and organizational device was examined based on prior literature.[12] Interactions were selected using criteria of $p \leq 0.01$ for addition to the multivariable model. Multivariable analysis selection was based on removal criteria of 0.10. Crosstabs, standard errors and collinearity were examined prior to running the multivariable logistic regression analysis. Model fit to the

observed data was determined using chi-square statistics (p<0.05).

Results

Demographic and Medication-Taking Characteristics

A total of 4,862 survey responses met inclusion criteria and were included in this analysis. Table 1 reflects the demographic and medication-taking characteristics of the sample. The sample predominantly identified as white (40.9%), female (59.6%), educated beyond the high school level 66.9%), and the majority reported having some type of healthcare insurance to cover prescription medications (94.9%). On average, the sample managed 4 prescriptions daily, with 47.4% reporting taking medications once daily. Prescription changes were reported by 58.9% of the sample, and individuals reported that most changes occurred once per year or less often than that.

Medication Adherence and Medication Nonadherence Likelihood

Nonadherence was self-reported by 25.8% (n=1209) of the respondents. Comparisons between those who reported medication nonadherence and adherence likelihood and the demographic and medication-taking characteristics are reported in Table 1. Those who reported nonadherence likelihood, were on average younger, female, and had more education and tended to report income earnings at the middle to upper end. Additionally, those reporting nonadherence also reported they took on average fewer oral medications (p=0.08) and had experienced changes to prescription medication regimens (p<0.001) in the past year. No differences were found with respect to race and ethnicity or total number of non-oral prescribed medications taken daily between the two groups. All other demographic and medication-taking characteristics significantly differed between the two groups. A summary of the pharmacy and home context variables and differences between adherent and nonadherent groups are shown in Table 2.

Logistic Regression Analyses

Binary logistic regression analyses were conducted to examine the relationships between nonadherence likelihood and the "Pharmacy context" variables (number of medications picked up from the pharmacy, separate trips made to pharmacy, use of mail/home delivery of medications) and "Home context" variables (use of an organizing device, management satisfaction, organization burden). All six

independent variables representing pharmacy and home contexts were significantly associated with nonadherence likelihood in separate univariate analyses (p≤ 0.25). When examining all possible two-way interactions between each of the pharmacy and home context variables using separate logistic regression analyses, the only significant interaction found was between the method used to organize/manage medications and being bothered by managing medications (p= 0.005). The additional hypothesized interaction between method used to organize/manage medications and age, based on prior literature, was not significant (p=0.752) and therefore was not included in the multivariable model.

Multivariable logistic regression with backwards elimination was used to examine the pharmacy (use of home delivery, number prescriptions picked up and visits to pharmacy) and home context (method used to organize/manage medications, satisfaction, and bother with management) variables and the demographic (age, sex, race/ethnicity, education, income, insurance) and medication (number of oral and non-oral medications, medication changes and frequency of taking) covariates associated with nonadherence likelihood. The two-way interaction between method used to organize/manage medications and being bothered by managing medications was also included in the analysis. Results of the multivariable logistic regression analysis are presented in Table 3. The final multivariable model was statistically significant, χ^2 (15, N=4,682) =307.27, p<0.001.

As shown in Table 3, the final model included all pharmacy and home context variables, the two-way interaction term and three covariates significantly associated with nonadherence likelihood. In the pharmacy context, picking up fewer prescriptions from the pharmacy, taking fewer trips to the pharmacy and never, rarely or sometimes using mail order compared with always using mail order pharmacy services were significantly associated with nonadherence likelihood. In the home context, reporting not being satisfied with the medication organization method used was associated with increased nonadherence likelihood, compared with those who reported satisfaction. The odds ratios for pillbox use and pill pouches indicate these methods are associated with decreased nonadherence likelihood, compared with using the original packaging. However, the interaction between being bothered with managing medications and the method used to organize medications remained significant in the multivariable model and this interaction was observed among the group using pill pouches and reporting being bothered by managing medications. Using pill

Table 1 Respondent Demographic and Medication-Taking Characteristics

	Total Sample, N=4682	Nonadherent, n=1209	Adherent, n=3473	p-value
Demographics				
Age, mean (SD)	52.73 (16.43)	50.18 (16.46)	53.62 (16.33)	<0.001*
Sex, n (%)				<0.001*
Male	1890 (40.4)	432 (35.7)	1458 (42.0)	
Female	2792 (59.6)	777 (64.3)	2015 (58.0)	
Educational level, n (%)				0.033*
Less than High School	249 (5.3)	65 (5.4)	184 (5.3)	
High School	1303 (27.8)	303 (25.1)	1000 (28.8)	
Some College	1719 (36.7)	481 (39.8)	1238 (35.6)	
Bachelors or higher	1411 (30.1)	360 (29.8)	1051 (30.3)	
Education as dichotomous, n(%)				0.020*
High School or less	1552 (33.1)	368 (30.4)	1184 (34.1)	
More than High School	3130 (66.9)	841 (69.6)	2289 (65.9)	
Race, n(%)				
White	1917 (40.9)	472 (39.0)	1445 (41.6)	0.282
Black or African American	334 (7.1)	88 (7.3)	246 (7.1)	0.466
American Indian/Alaska Native	61 (1.3)	18 (1.5)	43 (1.2)	0.396
Asian	72 (1.5)	21 (1.7)	51 (1.5)	0.395
Native Hawaiian or other Pacific Islander	5 (0.1)	2 (0.2)	3 (0.1)	0.406
Other race	72 (1.5)	20 (1.7)	52 (1.5)	0.473
Ethnicity, n(%)				0.498
Hispanic or Latin	213 (4.5)	51 (4.2)	162 (4.7)	
Not Hispanic or Latin	2167 (46.3)	547 (45.2)	1620 (46.6)	
Income, n(%)				0.117*
$19,999 or less	795 (17.0)	203 (16.8)	592 (17.0)	
$20,000 to $39,999	1083 (23.1)	258 (21.3)	825 (23.8)	
$40,000 to $59,999	830 (17.7)	234 (19.4)	596 (17.2)	
$60,000 to $99,999	1046 (22.3)	288 (23.8)	758 (21.8)	
$100,000 or greater	928 (19.8)	226 (18.7)	702 (20.2)	
Insurance Coverage for Medications, n(%)				0.934
Yes	4444 (94.9)	1147 (94.9)	3297 (94.9)	
No	238 (5.1)	62 (5.1)	176 (5.1%)	
[†]Type(s) of Insurance, n(%)				
Work insurance	1867 (40.0)	516 (42.1)	1375 (39.0)	
Individual health plan	5014 (10.8)	113 (9.2)	401 (11.4)	
Medicare	1409 (30.1)	342 (27.9)	1093 (31.0)	
Medicaid	846 (18.1)	223 (18.2)	631 (17.9)	
Veteran Affairs	182 (3.9)	50 (4.1)	136 (3.9)	
Healthcare exchange	220 (4.7)	63 (5.1)	158 (4.5)	
Other insurance coverage	108 (2.3)	27 (2.2)	81 (2.3)	
No insurance	238 (5.1)	62 (5.1)	179 (5.1)	
Medication characteristics				
Total Number of Prescribed Oral Medications Taken Daily				0.08*
One	1038 (22.2)	271 (22.4)	767 (22.1)	

(Continued)

Table 1 (Continued).

	Total Sample, N=4682	Nonadherent, n=1209	Adherent, n=3473	p-value
Two	952 (20.3)	271 (22.4)	681 (19.6)	
Three or more	2692 (57.5)	667 (55.2)	2025 (58.3)	
Total oral prescriptions per day, mean (SD)	3.9 (3.7)	3.77 (3.4)	4.0 (3.8)	
Total non-oral prescriptions per day, mean (SD)	0.67 (2.5)	0.64 (2.0)	0.68 (2.6)	0.648
Frequency of oral prescription, n(%)				0.046*
Once a day	2221 (47.4)	555 (45.9)	1666 (48.01)	
2 times a day	1806 (38.6)	496 (41.0)	1310 (37.7)	
3 or more times a day	655 (14.0)	158 (13.1)	497 (14.3)	
Changes in prescription in the past year, n(%)				<0.001*
No Changes	1926 (41.1)	418 (34.6)	1508 (43.5)	
Changes occurred	2756 (58.9)	791 (65.4)	1965 (56.6)	

Notes: *Selection criteria p<0.25, †Respondents could have selected more than one option.

Table 2 Comparisons of Pharmacy and Home Context Variables Between Medication Adherence Groups

Variables	Total Sample, N=4682	Nonadherent, n=1209	Adherent, n=3473	p-value
Pharmacy Context				
Total number of prescriptions picked up per pharmacy visit, mean (SD)	2.6 (2.4)	2.4 (1.9)	2.8 (2.5)	0.001*
Total number of trips to the pharmacy taken in the past 6 months to pick up prescriptions?	9.1 (9.41)	8.4 (7.2)	9.4 (10.1)	<0.001*
How often do you use mail order/home delivery pharmacy?				<0.001*
Always	392 (8.4)	72 (6.0)	320 (9.2)	
Some of the time	808 (17.3)	238 (19.7)	570 (16.4)	
Rarely	553 (11.8)	192 (15.9)	361 (10.4)	
Never	2929 (62.6)	707 (58.5)	2222 (64.0)	
Home Context				
Organization method				0.001*
Original packaging	2367 (50.6)	664 (54.9)	1703 (49.0)	
Pillboxes	2039 (43.5)	469 (38.8)	1570 (45.2)	
Pill pouches	126 (2.7)	32 (2.6)	94 (2.7)	
Other	150 (3.2)	44 (3.6)	106 (3.1)	
Bothered by Managing Medications				<0.001*
Not bothered	2218 (47.4)	381 (31.5)	1837 (52.9)	
Bothered	2464 (52.6)	828 (68.5)	1636 (47.1)	
Satisfied with Organization				<0.001*
Satisfied	4579 (97.8)	1158 (95.8)	3421 (98.5)	
Not satisfied	103 (2.2)	51 (4.2)	52 (1.5)	

Note: *Selection criteria p<0.25.

pouches and reporting being bothered by organizing medications was associated with an increased nonadherence likelihood.

Younger age was significantly associated with nonadherence likelihood, in which each one-year reduction in age increased the odds of nonadherence by a factor of 1.01

Table 3 Final Logistic Regression Model of Variables Associated with Nonadherence Likelihood

	OR [95% CI]	P value
Demographic Characteristics		
Age	0.993 [0.988, 0.997]	<0.001
Sex		
Female compared to ^male	1.237 [1.075, 1.425]	<0.001
Medication Characteristics		
Changes in prescription in the past		
Yes compared with ^no changes	1.415 [1.224, 1.635]	<0.001
Pharmacy Context		
Number of prescriptions picked up from pharmacy	0.957 [0.925, 0.990]	0.010
Separate trips to pharmacy	0.982 [0.973, 0.991]	<0.001
Mail order ^Always compared to some of the time, rarely or never	1.712 [1.299, 2.257]	<0.001
Home Context		
Organization Method ^Original packaging	–	0.004
Pillbox	0.723 [0.569, 0.919]	0.008
Pill pouch	0.150 [0.036, 0.624]	0.009
Other method/device	0.732 [0.378, 1.416]	0.354
Bothered by Managing Medications		
Bothered compared with ^not bothered	2.132 [1.766, 2.575]	<0.001
Satisfaction with organization		
Not satisfied compared with ^satisfied	2.126 [1.417, 3.189]	<0.001
Organization method by bothered managing medications	–	0.012
Pillbox by bothered	1.113 [0.828, 1.496]	0.486
Pill pouch by bothered	8.280 [1.837, 37.314]	0.006
Other by bothered	2.207 [0.976, 4.992]	0.057

Note: ^Reference category.

(95% CI: 1.00–1.01). Females had 1.237 times [95% CI: 1.075–1.425] higher odds for reporting nonadherence likelihood than males and changes in medication had a 1.415 times [95% CI:1.224–1.635] higher odds for nonadherence compared with those reporting no changes. The covariates of education level, income and total number of oral medications taken daily did not significantly contribute to nonadherence likelihood and were not included in the final model.

Discussion

Findings from this secondary analysis of a large data set demonstrate that aspects of how adults manage and organize medications in pharmacy and home contexts are associated with their likelihood of being nonadherent, while controlling for age, sex, and changes to medications. Our findings add to the body of literature that has identified a substantial number of factors associated with

nonadherence,[2,23] while uniquely contributing understanding of inconveniences (or conveniences) in the management of medications in pharmacy and home contexts. Specifically, our findings indicate that the way that patients obtain their medications from a pharmacy, how they manage and organize their medications at home, including whether they are not satisfied with and bothered by medication management, are aspects that can affect the likelihood of adults taking medications as prescribed.

While our main finding is consistent with the variables that we hypothesized to be associated with nonadherence in our conceptual model and guided by the MACO framework,[10,18] the directionality of some of the associations with nonadherence was surprising. In particular, fewer separate trips made to the pharmacy and fewer numbers of prescriptions picked up at each visit were related to nonadherence. While this finding was surprising, similar findings have been reported elsewhere.[24–26] One plausible explanation for fewer trips and

prescriptions picked up from the pharmacy is that people may be obtaining some medications from mail order and also from a retail brick and mortar pharmacy which may negate the convenience aspects that mail order affords and subsequently lead to nonadherence. For example, Choudry and colleagues[25] observed that filling fewer medications per pharmacy visit was associated with less adherence, a finding that was particularly apparent among those using both retail and mail order services. Similarly, we found that nearly 20% of those that reported nonadherence sometimes used mail order, signaling that perhaps they were obtaining medications using both mail order and picking up prescriptions from a pharmacy. It stands to reason that getting medications from multiple sources and methods may increase management complexity. To date, emphasis has been placed on picking up prescriptions from multiple different pharmacies,[27,28] and not necessarily on different modes. Our findings and the existing literature reflect the importance of fully understanding individuals' experiences in the pharmacy context and simplifying their medication management to make it more convenient. Opportunities like medication synchronization,[29,30] having a home pharmacy,[31] and even a single mode for obtaining medications (only retail or only mail) might be important strategies to improve adherence.

The relationship between the type of organization method and nonadherence is particularly meaningful for intervention design. In the home context, with the exception of one subgroup, we found that pill boxes and pill pouches significantly reduced the likelihood of nonadherence compared with those who reported keeping their medications in the original packaging (ie, bottles). This finding is consistent with findings from a systematic review of 30 studies[32] and a meta-analysis of 52 studies[33] that both provide evidence for the effectiveness of packaging interventions (like pillboxes and pill pouches) to improve adherence. However, in the present study, we found that a small group of individuals using pill pouches reported they were bothered by managing and organizing medications which significantly increased their likelihood of being nonadherent. This finding suggests that other factors may mediate or moderate the effects of organization devices. Additionally, pill pouches can be purchased and filled at home, similar to pillboxes or they can come pre-packaged from a pharmacy and be delivered to home. In the present study, we are unable to determine if individuals using pill pouches were receiving them by mail or packaging them themselves. Pill pouches that come pre-filled and delivered directly to the home may be an approach to reduce perceived bother from medication

management and organization. This builds on our findings related to the pharmacy context previously described yet requires further study and consideration for improving individuals' satisfaction with selected methods.

While medication delivery to the home offers convenience, it does not resolve all of the complexities and other inconveniences involved with medication management. Satisfaction, or rather not being satisfied with one's method of managing and organizing medications, increased the odds of nonadherence likelihood by two-fold in our study. Similar findings have linked satisfaction with nonadherence;[34–38] however, these other studies focused on different aspects of satisfaction like provider communication[34–36] and satisfaction with medications[35,37] rather than satisfaction with the medication management and organization aspects, as in our study. Recent evidence suggests that packaging can improve adherence, but the maximal impact on adherence and clinical outcomes stems from the combination of the packaging with medication therapy management services.[39] This finding, combined with understanding of the inconvenience factors identified in the present study, underscores the importance of delivering interventions that make medication management more convenient as individuals manage medication aspects across both the pharmacy and home contexts.

Given the findings in the current study, future intervention research should focus on supporting individuals to optimize the benefits that these different types of organization methods have to offer combined with the important aspects of the pharmacy context. Individualized interventions are needed in order to optimize the effects of medication management and organization factors to ultimately improve adherence.

Limitations

There are several aspects of our study which may limit the strength of the interpretations. First, this is a secondary analysis of survey data. The survey was designed to understand individuals' experiences managing medications and was not specifically designed to measure all the potential factors influencing nonadherence. Second, because responses were self-reported, we had no means of confirming actual nonadherence. Third, our single question used as a measure of nonadherence did not specify a time-frame/recall period, which has been shown to improve the accuracy of self-reported data.[40] Instead, the survey item asked about non-adherence likelihood, which reflects intention towards future behavior, rather than representing past behavior. Although the selected self-report measure of nonadherence did not

meet these requirements, the percentage of individuals self-reporting nonadherence in our study is consistent with other reports of nonadherence[2,38] and consistent with reports that have used measures of nonadherence with established evidence of reliability and validity.[38] Fourth, this is a cross-sectional study design and our measure of nonadherence did not distinguish adherence by initiation, implementation and discontinuation of the treatment regimen, which are different processes of adherence that occur over time.[3]

Notwithstanding these limitations, the findings can be readily used to develop individual-level interventions. A key strength in our study is that our multivariable model reflects person-centric convenience factors that are largely modifiable. Our analysis suggests that always using home delivery of medications and supporting individuals to manage and organize medications, using strategies that do not bother them and that they are satisfied with, may reduce nonadherence.

Conclusion

The present study suggests that interventions that improve convenience may address an unmet need for patients and have a positive impact on adherence. Though reasons for non adherence are multi-factorial, this study suggests that convenience factors are important – both pharmacy convenience (number of prescriptions picked up per trip and number of trips to the pharmacy and use of home-delivery) and home management convenience (type of, satisfaction with, and burden of organizational methods). Improving nonadherence should focus on these largely modifiable convenience factors. Behavioral economics' "Nudge Theory" emphasizes the importance of increasing ease and convenience to steer people's behavior in a predictable way. Based on this theory, adherence should improve by making it convenient for patients to initiate and manage their medication. Emerging solutions that reduce time and burden associated with organizing and managing medications, such as pouch packing solutions combined with other interventions, that make organizing and obtaining prescriptions refills convenient, likely have the potential to improve nonadherence. Furthermore, optimizing existing organizational methods and streamlining interactions with pharmacies, be it with brick and mortar or online pharmacy services may make medication management aspects more satisfying and further improve adherence.

Acknowledgments

Disclosure

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