Who are the Digital Proxies?: Prevalence and Predictors of Digital Proxy Behavior in the United States

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Abstract

Background: Out of necessity, dependent adults often ask proxies to help manage their digital accounts. However, data on the prevalence and predictors of digital proxy behaviour is scarce, and piecemeal.

Objective: We aim to describe the prevalence and predictors of digital proxy behaviour among the US population, and associated demographic, behavior and care factors.

Methods: We designed a cross-sectional online survey with a nationally representative adult cohort. 657 US residents completed the survey.

Results: Our findings indicate that about 49% of the US population report having digital proxy duties, which are predicted by being male, younger, more educated, and helping with physical care. Of these, 59% handled both medical and financial duties, but each domain still has a few different predictors. Financial proxies are additionally predicted by having a higher income. In contrast, medical proxies are more
likely to come from larger families and are less likely to be from an underrepresented ethnicity in the US. The most commonly given reasons for being a proxy are linked to low perceived usability of the interface and are less so about the cognitive and physical disabilities of the adult delegator. These results suggest that reducing usability challenges may reduce some of the need for proxies.
Of all the digital proxies, about 2 in 3 report having formal access to the account. Hence, informal digital proxies are about one-third of all digital proxies, translating to about 18% of the adult caregiver population, or about 18 million people [23]. Of these informal digital proxies, 47.5% (medical) and 55.3% (financial) report knowing the login details, and 29.8% of (medical) 35.1% (financial) report using the accounts without the account owner present. The data indicates a higher than previously reported prevalence of proxy digital behavior, with an estimated 5.3 million people reporting risky login and independent use of digital accounts

Conclusions: The profile of a digital proxy is often younger, male, and better educated. When helping with digital accounts, the financial and medical digital proxies were motivated by similar reasons (low perceived usability) and had similar helping patterns. In both
groups, about 1 in 10 digital proxies were accessing and operating digital accounts without the presence of the account owner. We conclude this finding translates to an unacceptably high number of adults engaged in informal proxy tasks, which puts vulnerable owners at risk when they lack the capacity to manage their accounts. We call for the promotion of digital caregiver accounts with guardianship features. We further suggest that an initial intervention should educate users from lower-income groups while mitigating the barriers to formal digital proxy accounts. Clinical Trial: none.

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ABSTRACT

Out of necessity, dependent adults often ask proxies to help manage their digital accounts. Data on the prevalence and predictors of digital proxy behaviour is scarce. Hence, we contribute a survey study with a nationally representative sample (n=657) in the United States. The analysis shows that about 49% of the population have acted as digital proxies, predicted by being male, younger, more educated, and helping with physical care. Financial digital proxies are additionally predicted by higher income, while medical digital proxies are additionally predicted by larger family size and ethnicity. Among the digital proxies, about one in three reports having informal access to the account. Half of the informal access is by knowing the login details, and about one-third report using the accounts without the account owner present. We discuss the implications of these findings for security practices and the design of digital proxy accounts.

KEYWORDS

digital proxy, caregivers, patients, survey

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INTRODUCTION

The growth of chronic disease has exacerbated the care burden and strained the resources of healthcare systems worldwide [3]. In the United States (US), caregivers often have stepped into the resource gap, conservatively accounting for some $600 billion in economic activity in 2021, an increase of 27% from 2017 [6].

In aging nations (such as the US, China, and Japan), caregivers often need to help older adults manage their daily activities [14], usually caused by the loss of sound decision-making capacity associated with age-related cognitive decline, illness, or sudden trauma (e.g., stroke). Increasingly, this means that digital tasks are managed by people other than the account owner – but different from physical help, they require knowledge of personal digital credentials to carry them out [7, 20].

While practical in the short term, longer-term or widespread use of such informal access methods could put the dependant party at risk of financial abuse. For example, in the

National Elder Mistreatment Study in 2010, the one-year prevalence for financial abuse by a family member was 5.2% [7]. Furthermore, across all abusive relationships, financial abuse occurs in 98% of these relationships [24]. Thus, unauthorized access coupled with the accelerated growth of financial and medical services via digital means could further enable financial abuse among family members or in already abusive relationships.

Even when caregivers have good intentions, studies have revealed potentially fraught issues with unfettered digital access. Some care recipients do not want to share all medical data with caregivers [8], and caregivers may filter reports back to providers in ways that meet other perceived needs [22].

Formalizing digital proxy access can help to drive monitoring and accountability of the proxy while increasing the privacy of the delegator (i.e., the person giving official access to the account). In this paper, we define formal access by a caregiver to a digital account whereby the user is authorized to perform specific actions on behalf of the care recipient (e.g., through a proxy account). On the other hand, we define informal access methods such as sharing credentials or using the account on behalf of the care recipient in an unauthorized, unofficial manner. For example, in financial systems, formal digital proxy behavior is supported by the use of joint accounts, where both login and transactions are recorded and, therefore, offer the opportunity for monitoring.

In the field of Human Computer Interaction (HCI), the topic of digital proxy behavior and the predictors of such behavior have been studied with qualitative methods [30] and quantitative methods [32]. The findings suggest that more attention is needed on usable privacy and security to support the population of people who act as unofficial proxies. However, increasing resources on the problem requires data on the true scale of unofficial digital proxy behavior, something that is not yet available to us.

With an overarching goal of normalizing digital proxy access that protects dependent adults, our research is the first study to understand the scale of unofficial digital proxy behavior, including the degree of digital access privileges and practices. We conducted a nationally representative survey (n = 657) in the United States to report on the prevalence of digital proxies. Our investigation focuses on proxy behavior in medical and financial domains since these are the two main areas where impaired capacity requires the transfer of decision-making authority to caregivers [12, 44]. With this data, we sought answers to the following research questions:

- RQ1: What is the prevalence of digital proxies?
- RQ2: What factors predict the likelihood of being a digital proxy?
- RQ3: How common are informal methods when carrying out their digital proxy duties?

Through a generalized linear model, we examined the relationship between demographic factors and physical care behavior in taking up financial and medical digital proxy duties. Our findings indicate that about 49% of the US population report having digital proxy duties, which are predicted by being male, younger, more educated, and helping with physical care. Of these, 59% handled both medical and financial duties, but each domain still has a few different predictors. Financial proxies are additionally predicted by having a higher income. In contrast, medical proxies are more likely to come from larger families and are less likely to be from an underrepresented ethnicity in the US. The most common reasons for being a proxy are linked to low perceived usability of the interface and are less so about the cognitive and physical disabilities of the adult delegator. These results suggest that reducing usability challenges may reduce some of the need for proxies.

Of all the digital proxies, about 2 in 3 reports having formal access to the account. Hence, informal digital proxies are about one-third of all digital proxies, translating to about 18% of the adult caregiver population, or about 18 million people [23]. Of these informal digital proxies, 47.5% (medical) and 55.3% (financial) report knowing the login details, and 29.8% of (medical) 35.1% (financial) report using the accounts without the account owner present. The data indicates a higher than previously reported prevalence of proxy digital behavior, with an estimated 5.3 million people reporting risky login and independent use of digital accounts. Finally, we discuss the implications of

these findings on research and policy directions in usable privacy and security.

Lack of Existing National Surveys on Prevalence of Digital Caregiving

National surveys are often a source of information about the prevalence and predictors of behaviors of interest. Various US surveys have been conducted on caregivers and their digital activities (e.g., [6]), but they offer scant information on digital proxy behavior. In these surveys, the focus is either on describing the breadth and depth (intensity) of caregiving burden [1, 2] where digital tasks are one of several tasks. Finally, there has been some tangential research on how caregivers use gig economy platforms to support care [34].

In the area of legal, non-digital transfer of agency to a medical proxy, Yadav *et al.* [56] suggest that 1 in 3 adults in the US have medical directives as donors. Assuming a 1-to-1 ratio of donors and proxies, the expected prevalence of medical proxies could be about a third of the adult population. On the other hand, a study among the older (above 85 years old) patients in Germany suggests that these numbers could go up as patients age. It showed that as many as
64.6% have given medical powers of attorney, and the majority (76.7%) of proxies are adult children and grandchildren. The closest quantitative study we found is the work of Latulipe and colleagues [32] on financial digital proxies. These researchers conducted a survey with 42 people in Canada to inform the design of online banking systems and applications, access control models, and permission interfaces. The analysis shows that about 28% of the sample report having formal access, but a "startling" 59% of the sample reported knowing the care recipient's online banking credentials. The study goes on to express concern for the opportunity for abuse revealed by these numbers since having credentials to one account can mean access to many other accounts.

The survey data in the medical field often focuses on *patient* digital behavior but less on proxy digital behavior. A study on patient interest in sharing access to Personal Health Records (PHRs) showed that almost 4 of 5 respondents (79%) were interested in sharing their PHR access with someone outside their health system. Of these, they wanted to share access mainly with kin (with a spouse or partner (62%), a child (23%), or another family member (15%)) [57].

To our knowledge, there has not yet been a quantitative and nationally representative study in the US on digital proxy behavior that includes reporting on the prevalence of the proxies.

Known Predictors of Digital Helping Behavior

We next move to understanding the state of knowledge on predictors of proxy behavior. We also examine reported predictors in the related behavior of digital helping.

Previous research suggests that kinship with the care recipient is likely a key predictor of helping with medical care tasks. Technical support among families is often motivated by a perceived closeness with care recipient [39, 40], with qualitative studies describing how younger helpers assist older adults [29]. On the other hand, there is also evidence that older adults and non-kin are populations who may also offer help [30, 36].

Similarly, a survey of 20 groups comprising digital helpers and helped individuals (112 participants who are both kin and non-kin) [31] suggests that digital proxies are more likely to be younger. They additionally reported predictors such as self-reporting being power-users with higher levels of self-efficacy with technology. However, the same study found that other predictors such as gender, income, educational levels, a sense of community belonging, and community efficacy were *not* predictors of digital helping. Finally, the survey reports on the medium of help (often via text message or phone) and the purpose (setting up devices) but did not examine the way access to accounts might have been shared.

Thus, age and gender seem to be important predictors, but current evidence does not contextualize this information against general caregiving duties as detailed above. Knowing more about the predictors of such digital support behavior and its relationship to physical caregiving will help shed

light on designing secure and accessible proxy features in digital systems and applications, access control models, and permission interfaces.

Known Challenges of Proxy Accounts

Low Usability of Patient Health Portals. In a study of older adults pairs and their caregivers, Quinn *et al.* [43] found that both groups of users acknowledged the necessity of using patient health portals (PHRs) for documentation but reported that the low usability of these systems was a significant obstacle to their use. The authors suggested that additional training should be provided to this population, particularly in the area of digital health record keeping.

In addition, Wolff *et al.* [55] point out that family caregivers may face obstacles in obtaining health information due to providers prioritizing the security of electronic health records. This is despite the Health Insurance Portability and Accountability Act of 1996 (HIPAA) allowing for the reasonable sharing of information to provide quality care. Unfortunately, the need for stringent security protocols for accessing health data is a countering force to accessibility and can lead to increased difficulty for users, particularly among elderly individuals [27].

How is this usability barrier associated with proxy digital behaviour? It is likely that it leads to patients needing support in managing digital access to their health portals, and the proposed survey may be able illuminate the link between these behaviors.

Issues associated with Caregiver Access. Introducing formalized accounts for digital proxies in medical and financial digital systems comes with challenging privacy questions. For example, Ancker *et al.* [8] found that while most US national survey respondents are supportive of parents accessing medical records of teenaged patients, many also believed that a teenager might be less likely to discuss sensitive issues with doctors when their parents have medical record access. Similarly, an interview study with 22 older adults in Germany showed that patients did not want to share all medical data with caregivers [53]. Caregiver opinions were under-represented in this study (n=9), leading to less information about the caregivers' attitudes and perceptions of access to PHRs. Another interview study in the US suggested that patients recognized the practical benefits of caregiver access [33] but remained uncomfortable if the access included caregivers learning about stigmatized conditions or accessing financial billing information. From these studies, it is clear that wholesale access is undesirable, yet situations of increased dependency often necessitate sharing access in order to access digitized services.

Table 1. Summary of Survey Items and Inclusion

Survey Items	Reason for Inclusion in Survey
Demographics (Age, Gender, Education, Income, Housing, Siblings, Birth Order, Employment, Marital Status)	Age and gender previously reported as relevant Education, Income, and other demographics included for complete reporting
Persons who are helped	For capturing relationship with the account delegator
Instrumental Activities of Daily Living and Activities of Daily Living Support	To contrast relationship with physical, in-person caregiving
User Behavior (Method and Reasons for Log In, Usage Pattern, Logon via Formal and Informal Means)	To understand digital proxy usage behaviour
Both Financial and Medical Proxy Behaviour	To understand and contrast digital proxies for financial accounts versus medical accounts

Overall, this body of research suggests that concrete evidence about the scale and importance of

proxy digital account holders will help drive research and policy for digital access.

Summary

While digital proxying is an oft-reported behavior, there is little comprehensive information about the prevalence and predictors of such behavior. The literature suggests that low usability is a crucial reason adults grant other adults access to their accounts and often grant access to kin. Current evidence suggests that these proxies are usually younger, mainly next of kin, and have high technological self-efficacy. However, further evidence of how widespread digital proxying is and their access behaviors are unavailable. Hence, we propose a quantitative study of digital proxy prevalence and its predictors. We propose to examine both formal and informal access to clarify the scope of unauthorized digital access to accounts. Table 1 summarizes the predictors we propose for inclusion in the survey.

METHODS

We conducted a survey of adults on financial proxies, medical proxies, and medical decision-making with 107 questions in the US. It includes all demographic data and items relevant to digital finance and medical proxies. It excludes survey items on medical decision-making. The survey is available in the Supplemental Materials of this paper. The study was reviewed by the institutional review board of our university, with approval number [redacted].

In this section, we describe the definitions of the terms used, the survey design, and sources of the items we used, where available.

Language and Definitions

In this survey, we conceived of a *proxy* as someone who carries out tasks on behalf of another adult. We divided the tasks into physical and digital tasks.

In this paper, we use the term *delegator* to refer to the adult who requires help with these tasks, but in the survey, we used the simpler language of “helping another adult” to refer to the delegator. Additionally, we used this phrasing because we wanted participants to distinguish helping behavior from parenting duties where a person below 21 years old is helped.

We define *formal access* using the concept of delegation of authority in role-based access control (RBAC) [10, 21] models. Hence, when a caregiver has formal access, they are authorized to perform specific actions on behalf of the care recipient (e.g., through a proxy caregiver account in MyUPMC app [5]). On the other hand, NIST defines unauthorized

Table 2. Summary of 657 verified participants’ demographics.

Participants	675 total, 657 verified US National/Resident over multiple rounds of collection between December 2022 - February 2023	Income	<30K (193), 30-49K (150), 50-99K (197), 100-159K (74), 150-199K (28), >200K (15)
Gender	Female (332), Male (325)	Siblings	0 (84), 1 (176), 2 (163), 3 (99), 4 or more (135)
Marital Status	Married (266), Unmarried (262), Widowed/Divorced/ Separated (129)	Ethnicity	White (418), Black (107), Mixed (40), Hispanic/Latino (42), Asian (36), Native American (8), Others (6)

Age	21-24 (56), 25-29 (47), 30-34 (77), 35-39 (63), 40-44 (62), 45-49 (65), 50-54 (56), 55-59 (49), 60-64 (56), 65-69 (63), >70 (63)	Employment	*Employed:*[Full-time (279),Part-time (87), Self-employed (7)], *Unemployed:*[Retired (141),Disabled (20), Unemployed (119),Student (4)]
Housing	Single family home (435), 2/more unit (177), Mobile/Trailer homes (45)	Education	Degree & above (300), High school (329) Below high school (28)

access as the act of gaining logical or physical access without official permission to a network, system, application, data, or other resource [50]. Throughout this paper, we use the term *informal access* to describe these methods, such as sharing credentials or using the account on behalf of the care recipient in an unauthorized manner.

Survey Design

The demographics collected are summarized in Table 2. We included predictors previously identified in the literature such as *income*, *ethnicity*, *employment*, *education*, *housing*, *age*, *marital* status and *gender*.

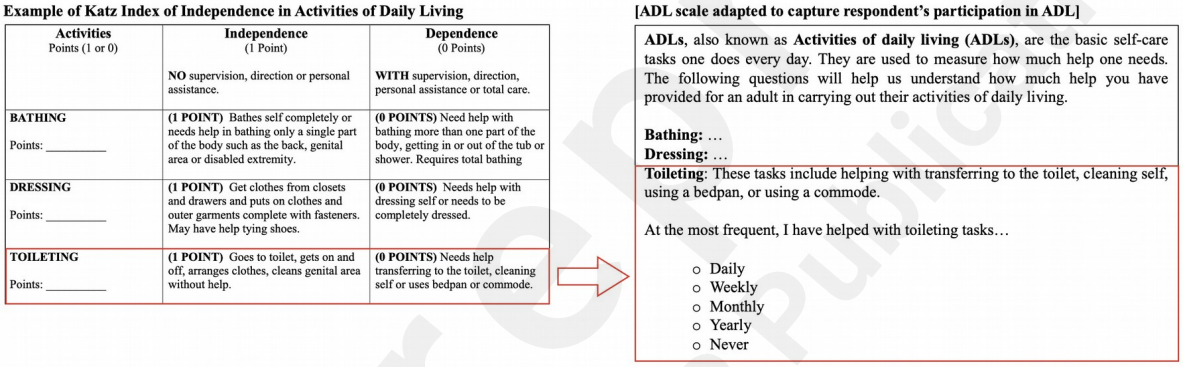

Fig. 1. (Left) Actual scale in Katz Index of Independence in Activities of Daily Living (ADL) [52] is adapted in our survey instrument (Right) to capture the frequency at which caregivers are involved with helping another adult in ADL.

We adapted two functional assessment scales to assess the prevalence of physical helping behaviors. The first is the Instrumental Activities of Daily Living (IADL) scale, which measures function in 8 areas of independent living, such as driving, housekeeping, and laundry [15]. The second scale is the Activities of Daily Living (ADL) scale. There are 6 ADL in the scale (washing, dressing, feeding, toileting, walking/moving, transferring) that make up independent living [52]. In both scales, the absence of any of these activities is used to measure disability in the adult being helped. In adapting these scales for participants of this survey, we framed the question to first describe the task, then ask what is the highest frequency of help the participants have offered (Figure 1). The options ranged from *daily*, *weekly*, *monthly*, *yearly*, to *never*. The intention was to capture the highest reported intensity of helping behavior in a person's lifetime.

We asked about financial digital helping behaviors in the next block of items. Participants were asked if they had financial proxies in any form of a joint account from a bank. Then, we asked if participants had ever helped another adult with digital financial accounts. Finally, we asked about the method of access, ways of helping with use, and the reasons for helping with access. We reviewed studies on potential barriers to adopting financial, legal, medical, and digital services and extracted possible options [16–18, 26, 35, 42, 45, 47, 54].

To identify the methods of helping with login, we asked: How have you helped another adult to log

on to their financial/legal digital services? You may select more than one option.

- I know the username and password for their online account(s)
- The adult logs in with a username and password and I help them (I don't know the username and password)
- The adult uses their fingerprint (or other biometrics) to log in
- The institution has given me my own separate login and password to help manage manage their online account(s)

To identify the methods of helping with using the digital services, we asked: How have you helped another adult use their financial/legal digital services online? You may select more than one option.

- I offer some help, but the person does it mostly independently
- I provide ongoing assistance while next to the person
- I use the person's account on their behalf, while they are present
- I use the person's account on their behalf, even when they are not present

To identify the reasons for helping with access, we asked: Provide the reason(s) why you think your help was needed to manage a digital service for another adult. You may choose more than one answer.

- The app is not user friendly for them
- They are unfamiliar with using a technology device to access the app.
- They do not have a device or equipment to access their digital accounts.
- They have cognitive limitations (e.g., existing conditions and cognitive decline with age) that constrain their ability to use the app.
- They have concerns about sharing their data with third parties.
- They have physical limitations (e.g., poor vision and poor motor skills) that constrain their ability to use the app.
- They see using the app as a difficult task that should be avoided.

In the last block of items, we asked about medical digital helping behaviors. The participants were asked if they had a caregiver account for assisting with medical matters. Then, we went on to ask if participants had ever helped another adult with digital medical accounts. Finally, we asked about the method of access and reasons for access, as listed above.

Table 3 shows how the participants were classified as having no digital proxy duties, informal digital proxy duties, and formal digital proxy duties for financial and medical domains, respectively. Note that respondents who answered 'Unsure' were classified as 'No' in our sample to increase our certainty that formal proxies have a clear report of formal access. In the sample, 189 participants were both financial and medical digital proxies, while 72 were financial (only) and 59 were medical (only) digital proxies.

Table 3. Question responses identifying participants who had no digital proxy duties, informal and then formal digital proxy duties related to finance (left) and medical (right).

Financial Digital Proxy?	No (0)	Yes (1)			
	No	Informal	Formal		
I have helped with digital financial access	No	Yes	Yes	Yes	Yes
I have a joint account	n.a.	No	Yes	No	Yes
How: my own separate account	n.a.	No	Yes	Yes	No
n	396	89	172		
Percent of Total	60.3	13.5	26.2		

Medical Digital Proxy?	No (0)	Yes (1)			
	No	Informal	Formal		
I have assisted another adult with digital medical services	No	Yes	Yes	Yes	Yes
I have a digital caregiver account	n.a.	No	Yes	No	Yes
How: my own separate account	n.a.	No	Yes	Yes	No
n	409	89	159		
Percent of Total	62.2	13.5	24.2		

Recruitment

The survey was sent to Qualtrics, a panel survey company that was tasked to recruit a nationally representative sample of US respondents from December 2022 to February 2023. The company

compensated the respondents with either cash, vouchers, or coupons. Exclusion criteria were that participants were not residents of the US and were aged below 21 years at the time of the survey. Residency was checked by verification performed by our research team, where we excluded responses with embedded data that failed the quality check for IP addresses and the participant's self-report.

Participant Summary

Our sample participants are nationally representative. We established this by comparing the various parameters (*income*, *age*, *ethnicity*, and *housing*) to the data from the most recent national census data by the US Census Bureau from 2020 [4], as per Appendix A. Note that the US census data percentage is reported as-is and may not add up to 100%.

Table 2 summarizes the key details of our data collection. We recruited 675 participants, with 657 respondents passing verification tests. Our analysis, moving forward, accounts for these 657 respondents. The average time these participants took to complete the survey was 18.24 minutes.

Scoring Procedure

Frequency of Physical Care Assistance. In adapting the IADL and ADL functional assessment scales, our scores are on a 0-4 Likert scale (i.e., 0: never, 1: yearly, 2: monthly, 3: weekly, 4: daily). We normalize the sum of the frequency of all IADL and ADL components to a range of 0-1, where 0 denotes a person never assisting in any key life tasks of another adult, and 1 denotes a person assisting in all aspects of IADL or ADL daily.

Digital Proxy Behavior. In Table 3, we demonstrate how we separated formal and informal proxies. We classified formal proxies as participants who report having had any kind of formal access, such as having a joint account, having a digital caregiver account, and/or having their "own separate account."

RESULTS

Prevalence of Digital Proxy Behavior

In our sample, the total unique number of participants reporting digital proxy behavior was 320 out of 657. Of these, 261 were classified as financial digital proxies, and 248 were classified as medical digital proxies. These groups had a substantial overlap, with 189 (59%) reporting both financial and medical digital proxy tasks.

Table 4. Model summary for financial and medical digital proxy.

Model	**Physical Care**	**Demographic**	**AIC**	**Deviances - df**	p R^2	X^2	$Sig.$
Financial Digital proxy	IADL, ADL	Age, Income, Gender:*Male*, Education, Marital: [Married,Unmarried]	683.58	Null: 882.86-656 df Residual: 665.58-648 df	0.25	217.28	0'***'
Medical Digital proxy	IADL, ADL	Age, Gender:*Male*, Education, Employment: [Unemployed], Siblings, Ethnicity: [Underrepresented], Marital: [Married,Unmarried]	666.73	Null: 870.94-656 df Residual: 644.73-646 df	0.27	226.21	0'***'

We further subdivided the respondents into those who reported using formal versus informal access

methods. 89 of 657 participants reported that they have been informal financial proxies, and the number was coincidentally the same for informal medical proxies (Table 3). Of these, 32 informal proxies have had both duties, making a total of 146 unique informal digital proxies, which is 22.2% of our population sample.

Next, we were interested in understanding who the delegators were (relative to the proxy). As plotted in Figure 2, of all respondents (n=657), 68% reported ever helping a family member, and approximately 30% supported a relative or a friend. We observed that digital proxy behavior is mainly for helping family and relatives, whereas physical helping behavior also extends to helping friends. For example, digital proxies made up 62% (227 of 449) of the respondents who helped with physical care matters for a family member.

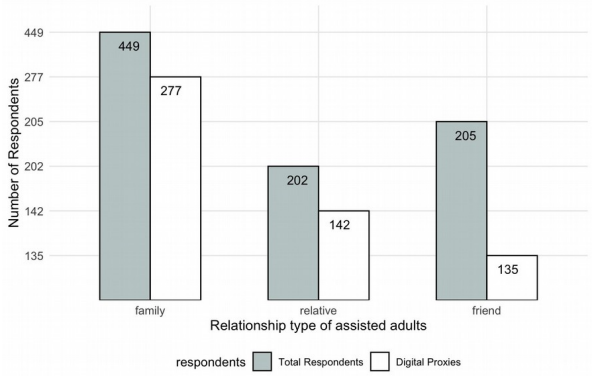

Fig. 2. Prevalence of digital helping in the population, categorized by reported relationship to the person who is being helped.

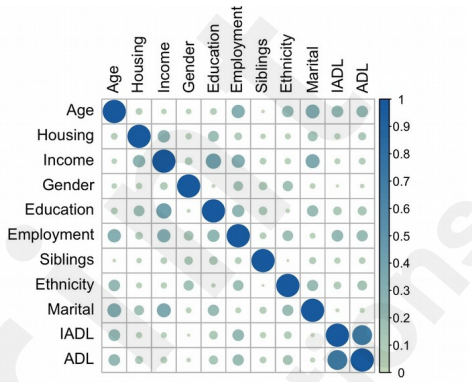

Fig. 3. Correlation matrix of predictors showing no correlation higher than r=0.71.

The rest of this paper investigates this sub-sample of digital proxies (financial digital proxies n=261 and medical digital proxies n=248), uncovering tension points in digital proxies to promote safe practices.

Modeling Types of Digital Proxies

We carried out a generalization of linear models (GLM) to investigate the relationship between participants' demographic factors and physical care behavior (IV: independent variables) in taking up proxy duties related to financial and medical matters (DV: dependent variables) for their delegator. This model choice is due to many predictors not being normally distributed and a mix of continuous and discrete values.

Table 5. Coefficient summary to predict a proxy undertaking financial digital duties

Coefficient	*est.*	**CI 95%**	Std.*e*	*z*	*Sig.*
(Intercept)	-4.25	[-5.54,-3.02]	0.64	-6.63	<0.000***
Age	-0.07	[-0.14,-0.00]	0.04	-2.06	0.039 *
Income	0.18	[0.01,0.36]	0.09	2.08	0.037 *
Gender: *Male*	0.57	[0.19,0.96]	0.19	2.94	0.003 **
Education	0.36	[0.00,0.72]	0.18	1.96	0.050 .
Marital: *Married*	0.18	[-0.36,0.73]	0.28	0.66	0.506
Marital: *Unmarried*	-0.32	[-0.91,0.27]	0.30	-1.06	0.290
IADL	3.49	[2.51,4.53]	0.52	6.78	<0.000 ***
ADL	0.82	[0.20,1.45]	0.32	2.59	0.009 **

Table 6. Coefficient summary to predict a proxy undertaking medical digital duties.

Coefficient	*est.*	CI 95%	Std.*e*	*z*	*Sig.*
(Intercept)	-3.77	[-5.21,-2.38]	0.72	-5.22	<0.000 ***
Age	-0.13	[-0.21,-0.05]	0.04	-3.36	0.001 ***
Gender: *Male*	0.61	[0.22,1.01]	0.20	3.03	0.002 **
Education	0.42	[0.06,0.78]	0.18	2.30	0.021 *
Employment: *Unemployed*	-0.34	[-0.78,0.09]	0.22	-1.56	0.120
Siblings	0.22	[0.07,0.37]	0.08	2.84	0.004 **
Ethnicity: *Underrepresented*	-0.47	[-0.90,-0.04]	0.22	-2.12	0.034 *
Marital: *Married*	0.13	[-0.42,0.68]	0.28	0.47	0.642
Marital: *Unmarried*	-0.46	[-1.07,0.16]	0.31	-1.46	0.143
IADL	2.69	[1.69,3.75]	0.53	5.13	<0.000 ***
ADL	1.39	[0.74,2.04]	0.33	4.18	<0.000 ***

Our model specifies the logit link between both sets of variables to clarify how the combination of IVs as linear predictors relates to participants' response values in being a proxy, *Yes = 1* or *No = 0*, for two types of digital duties, as per Table 3. Figure 3 shows the correlations between all predictors, with all correlations no more than $r = 0.71$. For this reason, we considered all variables in our model.

Goodness of Fit. We performed step-wise regression to procedurally determine the best combination of predictors and verify the goodness of fit for both models. Performing a backward selection resulted in a simplified model with the lowest Akaike Information Criteria (AIC). The lowest AIC value quantifies information loss due to model simplification without compromising performance. A lower value emphasizes a lesser tendency for the model to overfit our data.

In measuring the goodness of fit, unlike linear regression in which R^2 represents the proportion of variance explained by predictors in a model, there is no agreed-upon measure in logistic regression analysis analogous to R^2. Still, several competing measures of pseudo-R^2 exist. We calculated McFadden pseudo-R^2 to measure how well the model fits.

Defined as: $pR_{MF}^2 = 1 - (df_{residual}/df_{null})$, $df_{residual}$ denotes the maximized likelihood value from the current model that includes all predictors and df_{null} denotes the maximized likelihood value from the model with only an intercept and no covariates. A good model should produce a log-likelihood close to 0 since the ratio of the two log-likelihoods,

$df_{residual}$ and df_{null}, will be close to 1. Values of 0.2 to 0.4 for pR_{MF}^2 represent excellent model fit [37].

Table 4 provides the model summary for predicting each type of digital proxy duties. Simplifying our models to only selected predictors reduces AIC to 683.58 (from 690.9 in the finance digital proxy model) and 666.73 (from 668.13 in the medical digital proxy model). The pR^2 for $Financial$ and $Medical$ models are 0.25 and 0.27, respectively, indicating excellent model fit. Further, calculating the Chi-squared statistic, X^2, for both models, resulted in p<.000. The coefficient estimates for these models are summarized in Tables 5 and 6.

Demographic Profile

Our results yielded *age*, *gender*, and *education* as common demographic factors across finance and medical digital proxies at p<=.05. To delve deeper into this predictor, we plotted the distribution of unique digital proxies, across *age* and *gender* (Figure 4). Overall, we observed a majority of (finance and medical) digital proxies as male respondents; however, there is a decreasing participation trend among those over 55 years old. The log odds of a younger person and a male assisting with financial

digital matters increase by 0.07 and 0.57, respectively. Similarly, a younger person of the male gender is more likely to take up medical digital duties, with a 0.13 and 0.61 increase in log odds. Interestingly, as per Figure 4, this situation is reversed for digital proxies above 60 years old, with a predominance of female digital proxies.

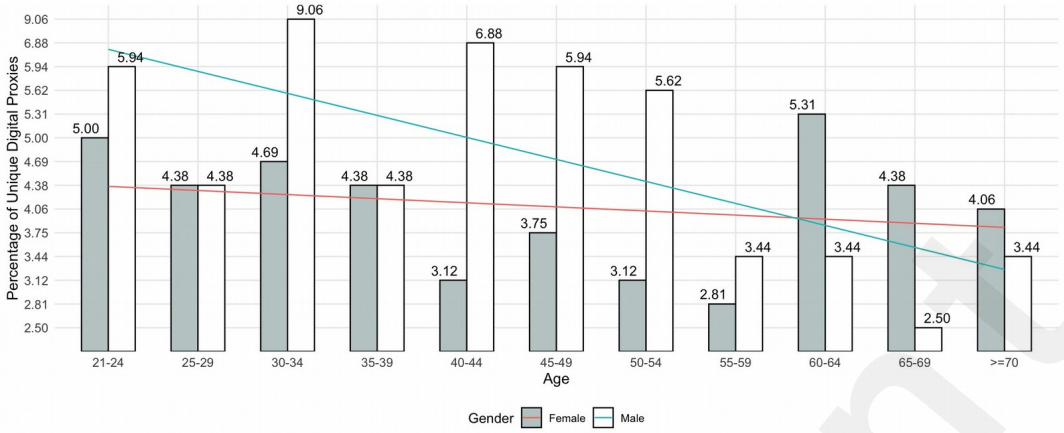

Fig. 4. Digital proxies by *age* and *gender* reveal younger adults of the male gender, however, with a trendline suggesting an increase in female digital proxies above age 60.

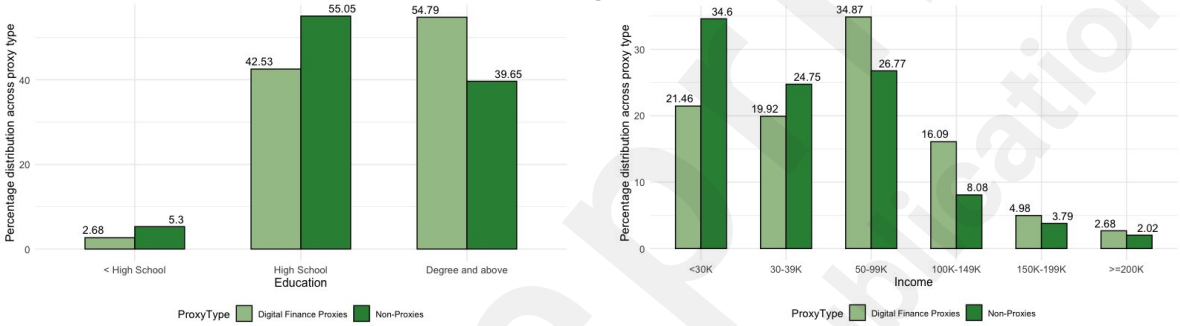

Fig. 5. *Education* distribution among financial digital proxies and Fig. 6. Household *income* distribution among financial digital non-proxies, normalized across proxy type, showing most proxiesproxies and non-proxies showing most non-proxies belonging to attaining higher education. lower-income households.

In terms of *education*, as per Figure 5, most finance digital proxies attained a college degree. We observed a similar trend among medical digital proxies, where 54% (n=134) were college-educated. For a one-unit increase in one's education bracket, the log odds of assisting finance and medical digital duties increase by 0.18 and 0.42, respectively. *Income* is additionally a significant predictor for finance digital proxies at p<.05. As per Figure 6, most proxies within the $50k-$99k which includes the national average of about $70K per household [48]. Specifically, the log odds of assisting financial digital duties increase by 0.36 for a one-unit increase in one's income and education bracket. In contrast, most participants who were not finance digital proxies reported a household income threshold of less than $30K annually.

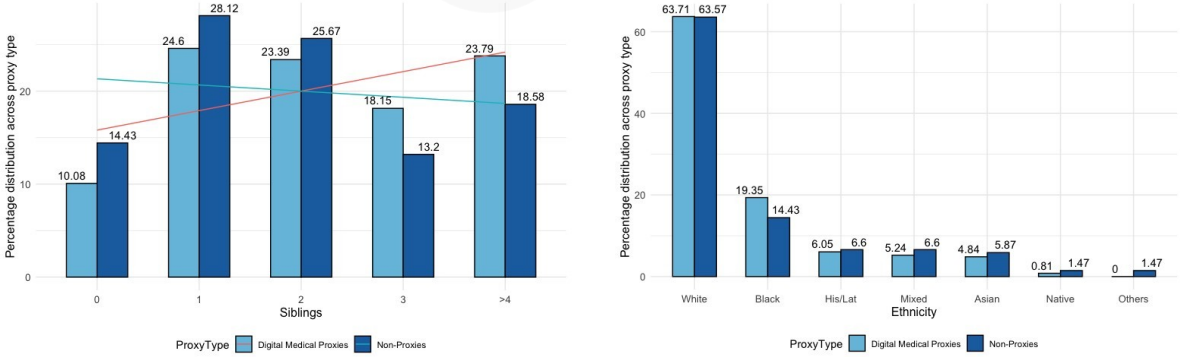

Fig. 7. Distribution in the number of *siblings* among medical Fig. 8. Distribution in *ethnic* groups

among medical digital proxdigital proxies and non-proxies, normalized across proxy type. ies and non-proxies, normalized across proxy type.

Additional significant predictors relevant in determining medical digital delegators include the number of *sibling*(s) a person has and *ethnicity*. As per Figure 7, we observed an increasing trend of medical digital proxies with more siblings. For every one-unit change in the number of siblings, the log odds of a person assisting with medical digital duties increase by 0.22. Black, Native, Asian, Latino, Hispanic, and mixed ethnic groups make up the minority 36% of medical proxies. While we observed negligible differences in the percentage distribution of Whites taking up medical digital duties, the underrepresented communities were less likely to take up medical digital proxy duties, with log odds decreasing by 0.47. Figure 8 suggests that there may be some variation among underrepresented ethnic groups, but the differences between proxies and non-proxies are not significant (p>.5).

Involvement with Key Life Tasks

Recall our scoring in the frequency of IADL and ADL assistance spans from 0 to 1, where 0 denotes a person never assisting in any key life tasks of another adult, and 1 denotes a person assisting in all aspects of IADL or ADL daily.

Figure 9 compares the involvement in two types of key life tasks, IADL and ADL, among finance and medical digital proxies. The median frequency of IADL assistance is 0.83 among finance (stdev=0.19, mean=0.77) and 0.79 among medical (stdev=0.18, mean=0.77) digital proxies. In contrast, the distribution of ADL assistance scores spans a broader range, with the median frequency equal to 0.75 among both digital proxies (finance: stdev=0.34, mean=0.65, medical: stdev=0.32, mean=0.67). Note we did not remove outliers as they represent natural variations in the population.

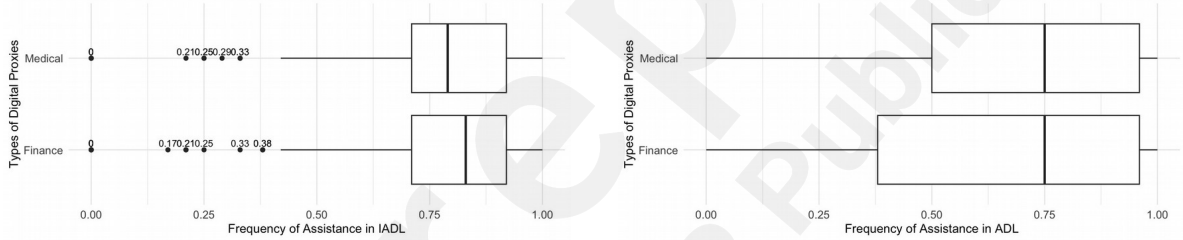

Fig. 9. Distribution of IADL and ADL assistance score among digital proxies.

IADL and ADL are significant predictors of finance and medical digital proxies, achieving p<.01 significance. That is to say, the more a person assists another adult with their physical care activities (IADL and ADL), the log odds of them being a financial digital proxy increases by 3.49 and 0.82, respectively. Correspondingly, the log odds of a person being a medical digital proxy increased by 2.69 and 1.39 with increasing IADL and ADL responsibilities.

Summary of Findings on Predictors of Being a Digital Proxy

In this section, we ran a regression analysis to investigate the predictors of being a financial and medical digital proxy for another adult. The evidence indicated a strong tendency for those assisting others with IADL and ADL to undertake digital financial and medical responsibilities. Further, our results found *age*, *gender*, and *education* as common non-modifiable factors significantly influencing a person being financial and medical digital proxies. We noted additionally that after age 60, female respondents are the predominant digital proxies. A person with a higher *income* bracket is more likely to take up financial digital proxy duties, though *income* plays no role in predicting medical digital proxies. Nevertheless, most proxies were in the household income bracket that included the national average household income. A person from an underrepresented ethnic group was less likely to take up medical

Behaviours of Digital Proxies

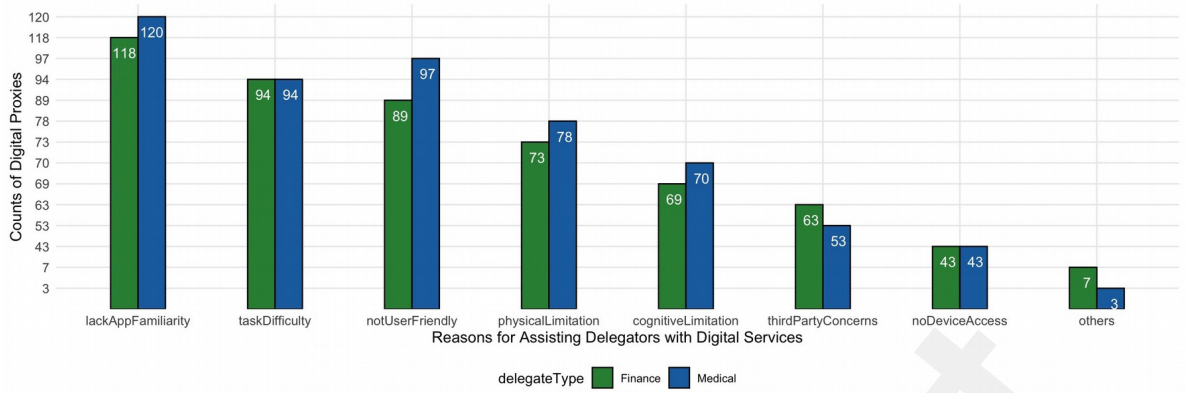

Fig. 10. Reasons for digital proxies to manage digital accounts for other adults, showing a predominance of usability-linked reasons. Refer to Survey Design section for full questions

Respondents who identified themselves as digital proxies were asked to choose the most common reasons to manage accounts for others. Participants could choose more than one option. In Figure 10, we note that across financial and medical digital proxies, the adult's lack of familiarity with the app (Finance n=118 | Medical n=120), perceived task difficulty (Finance n=94 | Medical n=94), and low usability (Finance n=89 | Medical n=97) were the main reasons for the proxy behavior. We also note that less modifiable reasons, such as physical or cognitive limitations of the account owner, were present but not the top reported reasons.

With these challenges in mind, our analysis now turns to the actual practices of informal digital proxies who reported access to the delegators' accounts without having proxy accounts. Recall that we observed an unanticipated reversed effect of increasing participation among female digital proxies above 60. We used this split to further investigate the profiles of digital proxies, and our results yield a remarkable and intriguing tendency among older female respondents to adopt formal digital proxy practices. As per Figures 11 and 12, the ratio of formal versus informal practices is highest for older females (about 3:1), which goes against the general trend of about 2:1.

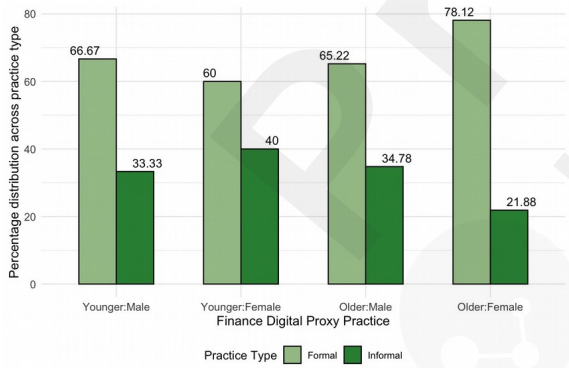

Fig. 11. Distribution among financial digital proxies, normalized across practice type, showing increased formal practices by older

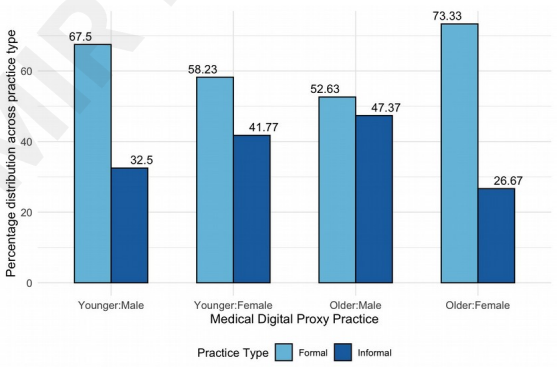

Fig. 12. Distribution among medical digital proxies, normalized across practice type, showing increased formal practices by female proxies.

Informal Proxies' Login Methods

In what follows, we continue to examine the behaviors of all informal proxies (n = 146). We examine how informal proxies, who make up 22.2% of the total sample population, helped their delegators with *logging into* digital accounts. We asked about three login methods and report them in Figure 13. Participants could select more than one option, relabeled in the following order: (1) I know the username and password for their online account(s) - *haveKnowledge*, (2) The adult logs in with a username and password and I help them (I don't know the username and password) *noKnowledge*

and, (3) The adult uses their fingerprint (or other biometrics) to log in.- *requireBiometrics*.
We can see that for both financial and medical informal proxies, more than 5 in 10 informal proxies report knowing both the username and passwords of the delegator, about 3 in 10 informal proxies report that they have assisted the delegator to login without knowing their credentials. Finally, about 2 in 10 mentioned that the delegator used biometrics to log in. Conclusively, about half of informal proxies reported having knowledge of the delegator's credentials, which potentially may lead to a high risk of misuse.

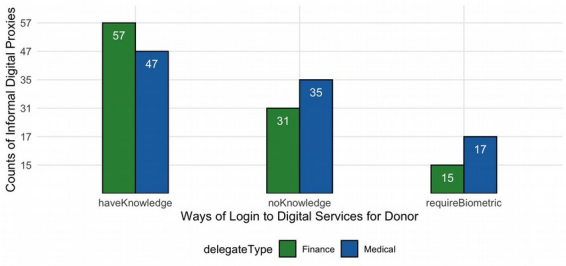

Fig. 13. Counts of reported methods of logging in to digital accounts account login by informal proxies.

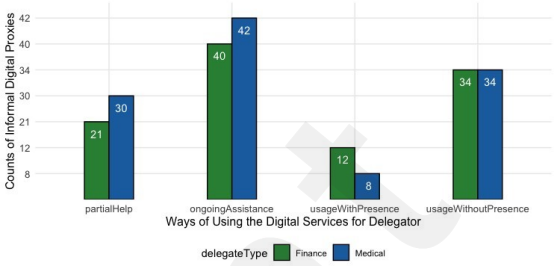

Fig. 14. Count of reported methods of using digital accounts by informal proxies.

Help with Using Digital Accounts

Participants were asked how they help other adults with *using* their digital accounts, as reported in Figure 14. Participants could choose more than one of the following options, relabeled in the following order: (1) I offer some help, but the person does it mostly independently - *partialHelp*, (2) I provide ongoing assistance while next to the person - *ongoingAssistance*, (3) I use the person's account on their behalf, even when they are not present. - *usageWithoutPresence*, and (4) I use the person's account on their behalf, while they are present. - *usageWithPresence*.
We report the distribution of methods practiced by informal proxies using delegators' accounts in Figure 14. Most of the informal proxies provide some form of assistance while being beside the delegator. However, about 1 in 10 report using the account on their behalf without the presence of the delegator.

Qualitative Insights

Each section of the survey had an open-ended question asking for other reasons for helping, other methods of logging in, and other methods of helping with using accounts. However, there were only a handful (n=3) of responses, and these did not offer any further insight into the survey data. Hence, we do not report any findings here.

DISCUSSION

This study aimed to quantify the predictors of digital proxies in financial and medical services. Here, we discuss the implications of our findings.

Prevalence of Digital Proxy Behavior

Our findings show that 49% (n=320) of all respondents are unique digital proxies. Assuming sample representativeness, we extrapolate that about half the US population are digital proxies. A substantial number of respondents, 189 of 320 (59%), have both roles, while 72 of 320 (≈ 23%) were only financial digital proxies, and about 59 of 320 (18%) were only medical digital proxies.
Among these digital proxies, 26.2% report formal financial access, and 24.2% report formal medical access (Table 3). This number is similar to data previously reported in Canada [32] with 28% of their sample reporting formal access.
Across the total sampled population (n=657), ≈ 11% of our sample were only financial digital proxies, and ≈ 10% were only medical digital proxies. We do not know if these were proxies that

would eventually take on a second digital proxy role, but it is likely to be so in the future, given that most digital proxies took up both roles.

Digital Proxies who are Male, Younger and Better Educated

Our findings show that digital proxies often take on both medical and financial proxy duties (about 59% of the digital proxies). Both types of digital proxy had similar predictors of being younger, male, educated individuals who help with physical care tasks. Being younger and male increased the odds of being a digital proxy by almost eight times and being a medical digital proxy by five times. This trend is consistent with previous work that reported a preponderance of male [31] and younger [29] digital helpers.

The predominance of male individuals stands in stark contrast to national studies of caregiving, where fully 75% of unpaid caregivers are female. In fact, it is often reported that male caregivers are *less* likely to provide care [6]. Upon closer examination, our data shows this may be the case above age 60 (Figure 4, where older female adults lead in digital proxying). We conjecture this occurrence may be explained by survivability, as women generally live longer than men [38], or a cohort effect. More research is needed to explain this phenomenon, as well as the odd finding of more formal access among women above 60. Finally, it may be that previous national caregiving studies focus on physical care tasks (defined as “assisting others with activities of daily living and/or medical tasks”) [6]. Hence, we conclude that digital proxy tasks are often delegated to younger, male, more educated kin who help with physical care tasks, but this profile may not hold when discussing older digital proxies.

Differences between Medical and Financial Digital Proxies

Our sample differentiated medical digital proxies by the number of siblings, not being in an underrepresented ethnicity. The insignificant differences between minority groups require more research to draw concrete conclusions on the tendency of digital proxy practices from ethnic and familial perspectives.

On the other hand, a financial digital proxy was predicted to have higher income brackets, previously shown to be associated with higher financial literacy [9]. We also observed that helping with physical tasks (IADL and ADL) strongly predicted being a digital proxy but that there was more variation in the frequency of assistance of higher dependency tasks among financial digital proxies. The data suggests that while physical caregiving predicts digital caregiving, it may be that financial digital proxies are less co-present in managing daily physical care tasks. This emerging picture is consistent with [32], where much of financial assistance is via online banking, which permits remote work. It also stands in contrast to the predictors of medical digital proxies, where the pattern of helping frequently with daily care is more consistent (Figure 9), indicating a closer relationship between daily physical care and digital medical proxying.

Our findings from digital proxy behaviors suggest medical digital proxies have just a slightly higher proportion of informal proxy behavior. This practice may be due to medical digital proxy accounts being a more recent phenomenon compared to financial digital proxy accounts. The gender and age-based distributions also suggest that it is mainly the older males who account for informal medical proxy behavior, but not the older females.

Taken together with the first point on the male, younger, educated digital proxies, these findings on the differential predictors lend weight to qualitative studies that report how different caregivers have different roles in supporting the patient in illness [46, 51]. Future research should consider how different age, gender, and ethnicity profiles account for informal proxy behaviors.

Within each group, participants were twice as likely to be formal digital proxies as informal digital proxies, thus suggesting that when people take on digital proxy duties, about two-thirds do so with formal means. This practice suggests a reasonable knowledge of and availability of proxy accounts,

but the remaining one-third may have barriers to obtaining these accounts. Given the projected caregiver population in the US in 2020 (53 million) [23], there may be a user group of about 18 million people in the US that remain as informal digital proxies. In our sample, about 1 in 10 of these respondents indicate they can independently log in to digital accounts and use them without the owner's presence. Assuming that they may be under-reporting undesirable behavior, we estimate that approximately 5.3 million to as many as 18 million people in the US currently use digital accounts through unauthorized means.

Informal Digital Proxying and the Risk of Elder Financial Abuse

Our findings speak to studies on delegation by other researchers. Delegation, as Dunphy *et al.* describe, involves a delegator entrusting another individual with access privileges to personal accounts with the expectation of them carrying out specific instructions [20]. The authors argue that current barriers to usage - usability, primarily - create the need for more flexible, spontaneous permissions to meet delegation needs. The findings of this study support the argument that usability problems affect a large number of people and may increase the likelihood of informal proxying.

However, the security literature and the literature on elder financial abuse do not seem to support a simple recommendation for more formalized methods for proxying. We refer to the literature on Routine Activities Theory [49], where elder abuse is seen as a largely opportunistic activity that arises from the absence of safeguards and the presence of habituated control over the elder. Such possibility causes us to speculate if the necessity of informal digital proxying, where account credentials are given away, can support abusers inclined toward control. Our findings describe a prevalence of 49% of respondents having formal or informal access. If we simply enable more access, we are not addressing issues of routinized control.

In applying Routine Activity Theory to explaining financial elder abuse, Setterlund *et al.* also calls for policy to create the presence of more "capable guardians to oversee family asset management." In the field of HCI and security, one possibility is to call for research into and building proxy systems that also automate this guardianship of the delegator's interests. A feasible mechanism is the adoption of *'legacy contacts,'* which has widely been implemented in social media accounts for post-mortem stewardship [13] and also recently recommended by Mentis *et al.* as a privacy strategy to minimize online security risks among older adults with mild cognitive impairment [41]. Similarly, Sabatino *et al.* [44], in discussing the development of law with regard to Powers of Attorney in the US, speculated that future delegation systems should not just ease the transfer of agency to a trusted other but also build in systems to monitor changes in the delegator's capacity to make sound decisions.

To this end, we initiate a call to action among policymakers and digital service practitioners to push for future solutions with preventive and capacity-checking mechanisms between dependent delegators and their digital proxies.

Policy Recommendations

The findings of this study suggest two areas of change. Firstly, it is important to promote formal methods for digital proxying. A primary target audience for education on methods for regulated proxy access would be our largest profile of digital proxies, the younger, male, and better-educated proxies. For financial digital proxies, the effort could focus on enabling people from lower income brackets to be responsible proxies when needed while addressing their privacy and security concerns, as detailed by [33].

Secondly, we call for more research to delve into the negative relationship between medical digital proxying and coming from an underrepresented ethnic group or the positive relationship with larger families.

Finally, the predominance of younger respondents as digital proxies causes us to consider the dwindling number of available younger adults to support these needs. The elder support ratios in the

United States (number of people aged above 65 to those aged 15-64) have increased from 19.8 in 1980 to 31.3 in 2023. The projection for 2075 is at 49.3 [19]. Hence, systems involving digital proxies may need to provide monitoring methods, support proxies for multiple older adults, or consider incorporating advanced planning tools for future financial and medical choices.

Design Recommendations

Improving usability of digital services. Our findings show that usability has been cited to be one of the key reasons why a care recipient relies on support from a care recipient. To improve the adoption of online services amongst such users and improve their self-efficacy in confidently performing transactions using online services, it is necessary to ensure that the mechanisms and services are inclusively designed and that they integrate well into the everyday practice of individuals [28] and that they support biopsychosocial aspects of autonomy for both the proxy and care receiver[41].

Designing effective proxy and gatekeeping mechanisms. As more older adults (and especially those with mild cognitive impairment) get access to online services, it is necessary to ensure that mechanisms designed for digital proxying consider the necessary trade-offs while balancing one's autonomy and agency and enabling support from their caregivers [41]. However, there are two main complexities around this. Firstly, a caregiver may not always act in the best interest of the care recipients. Next, the temporal nature of capacity changes due to physical and cognitive impairment (e.g., stroke, dementia, illness or experiencing trauma) [41]. Hence, gate-keeping mechanisms must ensure that the care recipients' best interests are protected and support such complex situations in an adaptive manner.

Limitations and Future Work

The survey items are all self-report items. We used a self-report method instead of examining patient health record data to capture non-official use of the accounts. However, self-report data also suffers from specific disadvantages due to how participants generally behave. In the case of this study, we risk respondents being too embarrassed to reveal private details about what they know are unsafe methods of online access. They may manage their responses to be more socially desirable. Given this limitation, it may be that the actual behaviors may be even less secure than reported.

For the items that ask for a recall of event frequency, we risk that the recall is incomplete or exaggerated. However, the resources needed to examine actual physical behavior frequency would be too onerous to apply when gathering data at scale.

The models developed from our analysis are not validated with new data. Predictive analysis is intended as future work, given that our current focus is to acquire a nationally represented dataset, which can be used to examine the relationship between variables and uncover significant factors of caregivers who engage in digital proxy behavior in the US. Future work will investigate the validity of these models with new data, including nationally represented datasets from a different region.Our study does not evaluate the detailed accounts of potential (financial and medical) abuse attacks happening within the digital realm and how care recipients cope with them [11]. Future work should investigate reports from care recipients on abuse attacks they have experienced and their coping strategies, helping us understand the motivations of abusers and enhancing threat modeling when developing proxy mechanisms.

We could not further examine the makeup of informal digital proxies in this study. A White paper in 2018 [25] suggests that the predictors of financial abusers who abuse elders are unknown and calls for research on this topic. To this, we add that future work should consider if access to the digital accounts of another adult is a possible predictor of perpetration of abuse.

ACKNOWLEDGEMENTS

We thank our early readers of this paper for their feedback and the participants of this study for their

valuable contribution.

CONFLICTS OF INTEREST

There are no conflicts of interest to declare

ABBREVIATIONS

We did not use any abbreviations in this paper.

DATA AVAILABILITY

The data that support the findings of this study are not available from the authors, as permission to reuse the data was not obtained.

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APPENDICES

A NATIONALLY-REPRESENTATIVE SURVEY SAMPLE

Table 7. Dataset is a nationally representative sample, as reported by the US Census Bureau census data from 2020 [4].

Factor	U.S. census %	User Study %	Factor	U.S. census %	User Study %
Income			Ethnicity		
<$30*k*	25	30	White	66.9	65
$30*k*-$49*k*	11.3	22	Black	12	16
$50*k*-$99*k*	29.7	30	Native	0.8	1
$100*k*-$149*k*	16.3	12	Asian	5.1	5
$150*k*-$199*k*	7.9	4	His/Lat	14.3	6
>$200*k*	9.8	2	Other/Pacific Islander	1	7
Education			Age		
< High School	12	4	21-24	9.4 (includes ages 18-20)	8 (excludes ages 18-20)
High School	35	50	25-29	4.7	7
Degree & above	53	46	30-34	14.8 7.4	12
			35-39	-	10
Gender			40-44		10
Male	49.1	49			
Female	50.9	51	45-49	1.9	10
Housing			50-54	4.7	8
Single family unit	69.3	66	55-59	12.1	7
2 or more unit	22.5	27	60-64	11	8
Mobile/ Trailer homes	5.2	7	65-69	5.2	10
			> 70	9.3	10