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Heterogeneity of traditional and digital media use among older adults: A six-country comparison

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ABSTRACT

The concept of aged heterogeneity has been associated with older adults' ability to adapt to the digital age without a systematic empirical analysis. We analyse retired adults' (aged 62 or more) use of traditional media and their digital equivalents in six countries. First, we ask whether heterogeneity in traditional and digital media use increases with age. Second, we study to what extent gender is related to this heterogeneity, and third, the country differences in the heterogeneity of media use in later life. We analyse the 2018 data (N = 5865) of the 'Older audiences in the digital media environment' survey using zero-inflated negative binomial models. The results provide partial support for aged heterogeneity in connection to digital media use. Gender differences were small and stable across cohorts, except in reading printed books, which increased with age among women. Country differences in the adoption and use of traditional and digital media were large.

1. Introduction

Recently, older adults' increasing engagement with new forms of digital media has attracted much scholarly attention [1–7]. New research has been produced concerning older people's access to the internet [1,8–10], types of internet use, especially in relation to health (e.g. [11,12], and their digital skills [13]). In contrast, older adults' use of traditional media, such as television, radio, or newspapers, has received scant attention. This is the case even though older media formats are still popular among older adults [14,15]. Consequently, the overall picture on older adults' media use has remained relatively narrow and is tilted towards digital media platforms. Hence, there is a need especially for cross-national comparisons that could help identify differences in media consumption cultures and in the current phase of digitalisation [cf. [8,14,15]].

In this article, we contribute to fill these gaps by investigating older adults' use of traditional and digital media in six countries: Austria, Canada, Finland, the Netherlands, Romania, and Spain. The continued convergence of media platforms makes it difficult to define separately what is 'traditional and analogue' and 'new and digital' [17,18], but studying the diversity of media use patterns requires making a distinction between older and newer media formats. While the distinction between printed books and e-books (or printed and e-newspapers) may be somewhat clear-cut, what is considered a traditional TV set and what is digital or internet television may vary considerably between people. We will approach this very diverse landscape of media use through the conceptual lens of 'aged heterogeneity' [19]. This well-established gerontological concept suggests that the variability in people's abilities increases with age, typically after the age of 65 [20]. Supposedly, aged heterogeneity also manifests itself in older adults' intensity of and ability to use various media platforms [21–23]. However, for now these claims have not been tested with a large survey data.

In theory, aged heterogeneity can occur in at least three ways in the context of media use. First, the likelihood for the discontinuation of media use may increase as people get older. This can result, for example, from unexpected health issues that force active older adults to give up using certain media for good [21]. Second, for the same reasons, older adults may spend less time on media activities that require dexterity, accurate vision, or good hearing as they age. Third, the variability in media use may also increase if older people start dedicating more time to media use, for example, as a response to decreasing physical mobility or narrowing social circles. In other words, the strengthening of both extremes, 'media non-users' and 'media heavy users', with the age of respondents would be a clear sign of the applicability of the aged heterogeneity thesis in the context of media use.

Studies have already shown that the use of digital technologies

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decreases either linearly [3,24] or even exponentially [1] with age. However, we still lack information on whether this connection is similar across various types of media and whether it can also be detected by studying the temporal aspect of media use. Unlike previous studies, we investigate simultaneously both media non-use and the amount of time spent on media to gain a more complete picture of aged heterogeneity. Our main research question is whether heterogeneity in traditional and digital media use increases with age. We will further define two sub-research questions that elaborate whether this age heterogeneity is dependent on (a) gender and (b) country context.

We analyse the 2018 wave of the international survey 'Older audiences in the digital media environment' to answer these research questions. The data involves seven countries (Austria, Canada, Finland, Israel, the Netherlands, Romania, and Spain) that participated in this second wave of data collection within a larger framework of the Ageing + Communication + Technologies (ACT) project. In each country, respondents who at the time of data collection were aged 62 or above were drawn from commercial online respondent panels. Due to the lack of time stamp data from Israel, we limited our analysis to the other six countries. We applied descriptive and bivariate statistics as well as zero-inflated negative binomial (ZINB) models. The data were analysed using Stata 15 software.

The article begins with an overview of earlier studies that have dealt with the heterogeneity of older adults' media use, especially from the perspectives of gender and country differences. The data and analytical methods are presented before proceeding to the results. The article ends by discussing the limits of the aged heterogeneity thesis in connection to media use and implications for future research.

2. Literature overview

2.1. Aged heterogeneity in media use: what is already known?

Watching television on a TV set is still by far the most popular mass media activity in Europe. According to Eurobarometer [25], 81% of the citizens of EU member states (aged 15 or above; hereafter, Europeans) reported watching television every day in 2017. The proposition increased with age, being the highest (92%) among Europeans aged 55 or above. In Canada, watching television also increases with age. In 2015, the highest rate of TV watching (86%) was registered among Canadians aged 75 or above, who spent, on average, 4.3 h per day on this activity [26]. In contrast, watching television via the internet was the most uncommon media activity (5%) among Europeans aged 55 or above in 2017. However, watching television online has steadily become an increasingly popular activity among Europeans [25].

Eurobarometer [25] also offers insight into the consumption of the written press and radio in Europe. The overall trend is that the number of daily readers of printed newspapers has steadily decreased from 38% to 28% between 2010 and 2017. At the same time, the share of non-users increased from 11% to 20%. In 2019, Europeans aged 55 or more were the most frequent users of the written press in the EU. The share of Europeans listening to the radio on a daily basis remained quite stable, being 50% in 2017.

To date, the studies applying the concept of 'aged heterogeneity' to media use have been mainly based on theoretical reasoning or qualitative research designs. For example, Sourbati and Loos [22,23] relate the idea of aged heterogeneity to a website's visual imagery, which – according to their results – considerably underplays the diverse characteristics of older people. Elsewhere, Loos [27] applies the aged heterogeneity approach to investigate older people's online information seeking practices. He suggests that, besides age, life stage, socialisation, and age-related functional limitations influence information-seeking behaviour in later life.

Elsewhere, the concept of aged heterogeneity has been more directly linked with the varied uses of information and communication technology (ICT). Hänninen et al. [21] explored the heterogeneous ways in which older people use ICTs in the context of geographically distributed extended families in Finland. They associated heterogeneity with individual variation in ICT use practices, showing that a person may be a proficient user of a certain new technology but require continuous assistance with another device or application. Fernández-Ardèvol [28], in turn, observed that older adults' heterogeneity is usually hidden in a wide 'residual' category of 'old people': the novel uses of mobile technology are not simply determined by a user's age, but also influenced by different life histories and earlier technology experiences.

Media generation studies provide a different viewpoint to aged heterogeneity. A generational approach to media use proposes that important historic events, often mediated by mass media, and the arrival of new media technologies would be formative elements of a shared generational identity [29,30]. As the formation of a generational identity takes time, older age cohorts are considered to have the strongest 'we sense' [29,31]. Hence, a generational attachment to technologies may explain why older people tend to stick to traditional media platforms [14,32] and the identification with new digital media and online communities decreases with age [33]. In contrast, the aged heterogeneity thesis can provide an explanation for why some practices of media use 'fan out' with age.

In statistical accounts, older adults' new media use is typically compared to that of younger age groups with the aim of investigating the age gaps in terms of access, skills, and use of new media [3,34]. For instance, Friemel's [1] study shows that while in 2009 only 4.9% of Swiss aged 85 or above used the internet regularly, the share proximately doubled at each younger age cohort at 5-year intervals (9.4%, 19.7%, 40.0%). Although Friemel's study suggests that the variability in internet use among the oldest people is remarkable, more rigorous analysis on this heterogeneity remains to be done. Based on the above, we defined two hypotheses in connection to RQ1:

H1a. While the total amount of time spent on digital media decreases with age, the variance of time use increases.

H1b. While the total amount of time spent on traditional media increases with age, the variance of time use remains stable or increases only modestly.

2.2. Media use from the gender perspective

In addition to age, gender is a major socio-demographic factor predicting digital inequalities [35]. According to official statistics, gender differences in traditional media use are relatively small both in the EU and Canada. While European women were slightly more often daily television users than men (84% vs. 78%) in 2017, men outnumbered women in daily online television watching (15% vs. 12%) and radio listening (30% vs. 27%) by a small margin [25]. In Canada, older men (aged 65 or above) were a little more likely to watch television (87% vs. 82%) and listen to the radio (6% vs. 3%) than women of the same age. Older women also spent, on average, less time on television viewing than men (3.9 vs. 4.2 h per day). In contrast, Canadian women aged 65 or above were more often engaged in reading activities than men of the same age (41% vs. 35%) [26].

Compared to traditional media, gender differences in older adults' digital media use are rather extensively studied. Studies suggest that the gender gaps in access to ICT in later life have considerably narrowed and in some respects even disappeared [13,19], but gender still differentiates ways of using ICTs. Näsi et al. [36] found that among Finns aged 60–79, men were about 1.5 times likelier than women to be active internet users in 2010. In the context of Spain, González et al. [37] have shown that among people aged 55–91, men engaged more actively in learning new things online than women. Ihm and Hsieh [35], in turn, discovered in the greater Chicago, USA, area, that among people aged 60 or more, women were more likely than men to use ICTs for social proposes. In Hargittai and Dobransky's study [13], women aged 55–97 in the USA reported more use of ICTs for getting news, obtaining

information, and consulting government services then men. In these and other studies, the applied age categories were typically rather broad and may therefore have hidden some more nuanced gender differences that are characteristic of aged heterogeneity.

Gender differences in media use typically reflect other structural inequalities that are prevalent in society [24,38]. Time use research, for instance, suggests that gender differences in the division of domestic work persist even after an age cohort has transitioned out of employment or parental responsibilities [26]. Time use therefore offers a valuable starting point to further unpack aged heterogeneity. It offers a temporal aspect to older adults' media use that goes beyond straightforward gender differences in the adoption of media and frequencies of use. Our hypotheses regarding the effect of gender on time spent on various media are as follows:

H2a. Gender differences in the time spent using *traditional media* are small and do not increase with age.

H2b. Gender differences in the time spent on *digital media* are modest and increase with age in favour of men.

2.3. Country differences in media use

There are a few explanatory frameworks for possible country differences in media use. Bagchi et al. [39] studied the effect of national cultural characteristics on the adoption of ICTs at the turn of the 21st century. Their results show that technology acceptance is at a higher level in individualistic countries (e.g., Finland and Canada) compared with more collective cultures (e.g., Mexico, Pakistan, and Uruguay). Bagchi et al. [39] demonstrated that the countries that received a high score on measures of individualism and cultural feminism, and a low score on power distances, showed a wider diffusion of information technology. PC and internet diffusion, in particular, were connected to high individualism. Shirahada et al. [16] highlighted some country differences between the UK and Japan while studying the use of online public services in later life. They argue, for example, that in the individualist countries with the wider geographical dispersal of the families like in the UK, older adults may count more on mobile communication in their social interaction and value more personal privacy and security than in collectivist cultures like Japan.

In Nimrod's [14] study on older adults' (aged 60 and above) media repertoires, the respondents living in Central Europe and Nordic Countries (Belgium, Germany, and Denmark) were highly represented in the identified group of heavy mass media users, while those residing in Mediterranean countries (Italy and Israel) were located more typically in the group of lighter media users. In another study, Nimrod [40] investigated older people's (aged 60 or above) transition to digital media across Europe and Israel. Her results show that older adults had replaced television watching and book reading with their digital equivalents to some extent, while they still mainly consumed these media via traditional platforms. Media displacement was found to be higher in Mediterranean countries (Spain and Israel) than in Denmark, the Netherlands, and Romania. Nimrod's [40] findings suggest that older adults are highly attached to the traditional forms of mass media consumption irrespective of country of residence. Based on this rather limited prior literature, we hypothesise as follows:

H3. Country differences in the time spent on both traditional and new media are small or non-existent and are relatively stable across age groups.

3. Data and methods

3.1. Data

The data we analyse in this article represent the second wave of 'Older audiences in the digital media environment: A cross-national longitudinal study' (N = 7940). This cross-national panel study was initiated and collected in the context of the ACT project coordinated by Concordia University, Canada. This first wave of data was collected with respondents aged 60 or above in 2016, and the second wave two years later in 2018. The second wave included the six original countries (Austria, Canada, Israel, the Netherlands, Romania, Spain) and one new country (Finland). The time stamp data that we use in this study was only collected in the second wave, which prevents longitudinal analysis.

Except for Romania, the respondents were recruited from commercial online panels in every country using age and gender quotas for stratified sampling. In all countries except Romania, the survey was also conducted online. In Romania, the interviews were conducted via telephone due to the low internet user rate among the older population. The reference figures for quota sampling were drawn from official national statistics. Excluding a possible distorting effect of dropouts, the second wave data are representative of internet users aged 62 or above in each country.

In this article, we analyse a sub-sample of retired respondents (N = 5865) to homogenise the sample in terms of the respondent's possibility of spending time on media. Data from Israel were excluded due to the lack of information on the weekday of the reference day, which is important to control when modelling time use. After these exclusions and missing information for independent variables, our effective sample size ranged from 4,650 to 4,865, depending on the media use category. Thus, our sample is not representative of the entire older age population in each country, but is restricted to internet users only. In addition, the older respondents are, the more selection there is due to the decrease in the internet use by age. The respondents may also be more active in their media use because the nature of data collection (online panel), which might introduce some upward bias in our estimates of digital media use.

3.2. Measurements

Our measures of media use are derived from the questions addressing how much time respondents spent on different media on the day before the date of response. We focus on three media use categories – watching TV, reading news and reading books – and separate time spent on them via traditional and digital platforms. Hence, we have altogether six measures of media use: (a) time spent watching television on a TV set; (b) time spent watching television on a computer; (c) time spent reading newspapers and magazines in the print version; (d) time spent reading newspapers and magazines on the internet; (e) time spent reading books in the print version (on paper); and (f) time spent reading books in an electronic version (on a digital reader, PC, laptop, tablet, mobile, phone, etc.). Respondents gave estimated hours and minutes for each media or could respond that they did not use the given media or do not remember. This information was recorded in four separate variables: hours, minutes, did not use, and do not remember. We excluded cases with extreme values on reported hours (e.g., watching a TV set over 30 h a day) using a standard cut-off value for the z-score, greater than 3 or less than −3, as the criterion for outliers. After this exclusion, we transformed reported hours for each media use to minutes and combined them with reported minutes. The value of zero was given to those respondents who reported having not used a given media at all. After these treatments, the measures we use in the analyses are indicative of total minutes spent on each media on the day before the date of response.

Our main predictor and control variables include gender, age, family status, education, income, type of living area, weekday of the reference day, and country. Gender is coded as a binary variable separating men and women. Age was coded into a three-category variable (62–64; 65–74; 75–91) to address possible non-linear associations with media use. Family status was measured as a four-category variable combining information on marital status (spouse; no spouse) and whether the respondent has children (children; no children). Education was treated as a three-level variable separating primary, secondary, and tertiary levels. Income was measured as a subjective estimation of the relation of

average monthly personal income before taxes to the average level in the country of residence. This variable was later coded as a three-level variable: below country average (a lot; slightly below average); similar to country average; above country average (a lot; slightly above average). Type of living area was also coded into a three-level variable: countryside (country village; farm or home at the countryside); town or small city; and a big city or suburb of a big city. In the analyses, we also control for whether the reference day (i.e., the day before responding to the survey) was a weekday or a weekend day as it may heavily influence how much time people can spend on various activities. Finally, the analysis includes data from six countries: Austria, Canada, the Netherlands, Romania, Spain, and Finland.

3.3. Statistical procedures

We began by describing the use of various media platforms by age groups. We provide distributional statistics and the Brown and Forsythe test [41] for equality of variances. Using the median as an estimator of central tendency, it is more robust than a mean-based Levene's test when dealing with skewed variables. After this, the effects of gender, country, and background factors on traditional and digital media use are analysed using ZINB models. As Tables 1 and 2 show, all media use variables were clearly over dispersed; their variance was greater than the mean value and there was an excess of zero values (i.e., no time spent on media use). Therefore, a basic linear regression or count variable model such as the Poisson model was unsuitable for the analysis. By contrast, the ZINB model is designed for modelling of variables with excessive zeroes and over dispersion. According to likelihood-ratio and Vuong tests, a ZINB model reflected the observed data more accurately than a zero-inflated Poisson or a simple negative binomial model.

In the ZINB model, the study population is divided into two latent groups: (a) respondents who report not using a given media (hereafter, media non-users) and (b) respondents who are susceptible to using the given media (hereafter, media users). Respondents belonging to the 'media users' group may or may not have a zero count for media use during the reference day. The underlying rationale for the excess of zeroes is that some subjects in the population may have zero probability of experiencing the event (i.e., using the given media), while others may differ in the count of events (i.e., minutes used in any given media).

A ZINB model estimates two regression equations simultaneously: one predicting whether media use occurs or not, and a second one predicting differences in the amount of time spent among media users. The first equation is the zero-inflated part and is based on a logistic regression model, while the second equation is the counts part and uses a negative binomial model [42,43]. Despite their clear advantages over standard count and linear models, zero-inflated models (ZIP and ZINB) have rarely been used in analysis of data with excess zeroes.

4. Results

In Table 2, we present the descriptive statistics on the media use variables by respondent age. As all measures are skewed, standard measures of central tendency and spread (e.g., mean and standard deviation) were not suitable. Instead, we compared these distributions using the share of zero observations and percentiles, and conducted the Brown and Forsythe median test for equality of variance.

Table 1
Descriptive statistics.

	Participating in activity		Participants			
	N	%	Mean	Std. Dev.	Min.	Max.
TV set	5777	93	217.58	121.90	1	945
TV computer	5769	15	99.19	82.30	1	630
Print news	5581	61	70.59	51.07	1	645
Internet news	5537	44	56.86	49.54	1	660
Books	5658	41	88.26	68.85	1	600
Electronic books	5768	12	86.48	59.21	1	345

According to the median test, there are significant differences between age groups in the variation of all media use measures, excluding reading electronic books. Distributional measures show that the share of zero minutes for print news and books decreases, and for internet news it increases, with the age of respondents. A similar decrease, albeit weaker, in zero minutes for traditional media and increase for its digital equivalent is also evident for watching TV. By contrast, the median (50th percentile) changes with age only for reading print media.

To sum up, the overall level of time use stays considerably stable across age categories, but the spread of values varies more. Thus, these preliminary and uncontrolled results provide support for hypothesis H1a maintaining that the variation in digital media use increases with age. Regarding hypothesis H1b, these initial findings are contradictory to what was assumed, as the variation in traditional media use decreases with age.

4.1. Heterogeneity in media use

In this section, we estimate age, gender, and country effects on print and digital media use using ZINB models. The results of these models are presented in Table 3. According to model fit indices, all models explain significantly better than the null model the number of minutes spent on a given media, excluding reading electronic books.

The coefficients of age categories show that both the amount of media use and share of media non-users change as an effect of age. However, the effects of age are somewhat inconsistent. Regarding the use of digital media, we find clear age effects only for the non-users of internet news. The older people get, the higher the probability for not reading news via the internet is. In turn, the older adults who read news from the internet do so irrespective of age. Regarding two other forms of digital media, watching television via a computer and reading electronic books, we find very small effects that are statistically significant, only that the middle age group (aged 65–74) seems to watch television via the internet slightly less than the youngest respondents do (aged 62–64). Thus, we find quite weak support that the variance in digital media increases with age, as suggested by H1a.

As to traditional media use, we find that the probability of not watching a TV set at all decreases with age, but the average amount of time used remains unchanged. A similar effect was found for reading print news and books, with the exception that the average number of minutes spent reading printed material increased towards older age groups. Thus, the use of traditional media seems to increase to some extent with age, as expected by hypothesis H1b. But contrary to the hypothesis, the variability in traditional media use indicated by zero-inflation seems to decrease by age group. This indicates that the use of traditional media may become more homogenous as media users age.

4.2. Modest and media-specific gender differences

Gender differences turned out to be more pronounced among media non-users than among the respondents who spent time on various media platforms. Regarding traditional media, we find significant gender differences in minutes spent watching a TV set and in the probability of not reading books: men spend more time watching a TV set and have a lower probability than women of reading books. However, men who read books spend an equal amount of time reading as women who read printed books. We find no difference between men and women in how much time they spend reading print news or the probability of not reading at all. These findings are in line with the first part of hypothesis H2a, which suggests that gender differences in traditional media use are small.

Compared with traditional media, gender differences are somewhat larger for digital media use. Men seem to spend more time watching TV

Table 2
Distributional statistics of media use (min.) variables by age group.

Age	Statics	TV set	TV computer	Print news	Internet news	Books	Electronic books
62–64	zero	8%	84%	49%	53%	67%	87%
	50th percentile	180	0	10	0	0	0
	75th percentile	270	0	60	45	50	0
	95th percentile	480	120	120	120	135	90
65–74	zero	7%	85%	38%	55%	58%	88%
	50th percentile	180	0	30	0	0	0
	75th percentile	260	0	60	30	60	0
	95th percentile	420	120	120	120	150	90
75–91	zero	6%	86%	30%	62%	55%	89%
	50th percentile	180	0	60	0	0	0
	75th percentile	270	0	90	30	60	0
	95th percentile	450	120	160	120	180	80
Brown and Forsythe median test of equality of variances *p*		0.020	0.055	<0.001	0.002	<0.001	0.421

Table 3
Estimates from zero-inflated negative binomial (ZINB) models predicting time spent on traditional and digital media use.

	TV		TV computer		Print news		Internet news		Books		Electronic books	
	Minutes for users	Non-user	Minutes for users	Non-user	Minutes for users	Non-user	Minutes for users	Non-user	Minutes for users	Non-user	Minutes for users	Non-user
Male	0.05**	−0.22	0.19**	−0.21*	0.04	0.03	0.08+	−0.21**	−0.07	0.56***	−0.08	0.36***
	(0.02)	(0.13)	(0.06)	(0.09)	(0.03)	(0.07)	(0.04)	(0.07)	(0.04)	(0.07)	(0.06)	(0.10)
65–74	−0.03	−0.27*	−0.17*	0.19	0.14***	−0.35***	−0.09	0.23**	0.02	−0.40***	0.02	0.16
	(0.02)	(0.14)	(0.07)	(0.11)	(0.04)	(0.09)	(0.05)	(0.08)	(0.05)	(0.08)	(0.07)	(0.12)
75–91	−0.03	−0.39*	−0.09	0.22	0.33***	−0.86***	−0.04	0.53***	0.09	−0.50***	0.08	0.27
	(0.03)	(0.18)	(0.10)	(0.13)	(0.04)	(0.11)	(0.07)	(0.10)	(0.06)	(0.10)	(0.09)	(0.15)
No spouse, with children	−0.06	0.02	−0.02	−0.20	−0.07	0.03	−0.04	−0.00	0.04	−0.11	−0.08	0.16
	(0.03)	(0.18)	(0.10)	(0.15)	(0.05)	(0.12)	(0.07)	(0.11)	(0.06)	(0.11)	(0.10)	(0.17)
Spouse, no children	−0.15***	−0.48**	−0.31***	0.10	−0.08	−0.38***	−0.11	−0.21*	−0.07	−0.01	−0.07	−0.04
	(0.03)	(0.18)	(0.09)	(0.14)	(0.04)	(0.11)	(0.06)	(0.10)	(0.05)	(0.10)	(0.09)	(0.16)
Spouse, with children	−0.19***	−0.46*	−0.13	0.06	−0.07	−0.40***	−0.08	−0.11	−0.10	−0.08	−0.07	−0.08
	(0.03)	(0.18)	(0.09)	(0.14)	(0.04)	(0.11)	(0.06)	(0.10)	(0.06)	(0.10)	(0.09)	(0.16)
Weekend	0.03	−0.01	0.18*	0.04	0.02	0.24**	−0.08	0.03	−0.06	0.06	−0.04	−0.11
	(0.02)	(0.14)	(0.08)	(0.10)	(0.03)	(0.08)	(0.05)	(0.08)	(0.04)	(0.08)	(0.07)	(0.12)
Education secondary	−0.03	0.11	−0.14	0.02	−0.05	−0.22	0.04	−0.22*	0.03	−0.38***	−0.16	−0.14
	(0.03)	(0.22)	(0.10)	(0.15)	(0.05)	(0.12)	(0.07)	(0.11)	(0.07)	(0.11)	(0.11)	(0.17)
Education tertiary	−0.19***	0.47*	−0.21*	−0.06	0.02	−0.51***	−0.02	−0.60***	0.06	−0.90***	−0.09	−0.39*
	(0.03)	(0.22)	(0.10)	(0.16)	(0.05)	(0.12)	(0.07)	(0.11)	(0.07)	(0.12)	(0.12)	(0.18)
Income average	−0.03	−0.15	−0.03	−0.18	0.04	−0.21*	0.04	−0.07	0.03	−0.13	−0.04	−0.18
	(0.02)	(0.17)	(0.08)	(0.12)	(0.04)	(0.10)	(0.07)	(0.09)	(0.05)	(0.09)	(0.09)	(0.15)
Income above average	−0.10***	−0.27	−0.16*	−0.00	0.04	−0.19*	0.02	−0.33***	−0.02	−0.14	−0.17*	−0.33**
	(0.02)	(0.14)	(0.07)	(0.11)	(0.03)	(0.08)	(0.05)	(0.08)	(0.04)	(0.08)	(0.07)	(0.12)
Living area town	−0.03	0.03	−0.03	−0.08	−0.05	−0.13	−0.07	−0.03	−0.03	−0.02	−0.03	0.05
	(0.02)	(0.13)	(0.07)	(0.09)	(0.03)	(0.08)	(0.04)	(0.07)	(0.04)	(0.07)	(0.06)	(0.10)
Living area countryside	−0.01	0.20	−0.03	0.20	−0.12***	0.16	0.02	0.27**	−0.03	0.03	−0.07	0.36**
	(0.02)	(0.15)	(0.08)	(0.11)	(0.03)	(0.09)	(0.06)	(0.09)	(0.05)	(0.08)	(0.08)	(0.13)
Canada	0.23***	0.28	−0.18*	1.14***	−0.34***	2.05***	0.10	−0.71***	−0.05	0.03	0.17*	−0.31*
	(0.02)	(0.19)	(0.08)	(0.13)	(0.04)	(0.14)	(0.08)	(0.11)	(0.05)	(0.10)	(0.08)	(0.15)
Netherlands	0.10**	−0.43	−0.82***	0.43**	−0.08	1.18***	−0.21*	−0.96***	−0.48***	−0.38**	−0.35**	−0.97***
	(0.04)	(0.33)	(0.18)	(0.17)	(0.05)	(0.18)	(0.11)	(0.15)	(0.09)	(0.14)	(0.12)	(0.18)
Romania	0.08*	−0.09	−0.54***	1.74***	−0.42***	2.70***	−0.06	−0.39**	−0.10	0.47***	−0.28	1.03***
	(0.04)	(0.26)	(0.13)	(0.22)	(0.06)	(0.16)	(0.10)	(0.14)	(0.08)	(0.13)	(0.19)	(0.27)
Spain	0.02	0.26	−0.25**	0.82***	−0.48***	2.34***	0.09	−1.53***	−0.13*	−0.07	0.12	−0.98***
	(0.03)	(0.23)	(0.08)	(0.14)	(0.05)	(0.15)	(0.08)	(0.13)	(0.06)	(0.12)	(0.08)	(0.16)
Finland	−0.08**	0.46*	−0.39***	0.64***	−0.12***	0.85***	−0.17	−1.06***	−0.12*	−0.18	−0.36*	1.86***
	(0.03)	(0.19)	(0.09)	(0.12)	(0.04)	(0.14)	(0.09)	(0.12)	(0.06)	(0.10)	(0.15)	(0.26)
Constant	5.57***	−2.31***	5.18***	1.01***	4.34***	−1.10***	4.13***	1.50***	4.61***	1.07***	4.73***	2.15***
	(0.04)	(0.29)	(0.15)	(0.22)	(0.07)	(0.20)	(0.13)	(0.18)	(0.10)	(0.17)	(0.17)	(0.27)
Observations	4865		4855		4672		4650		4753		4847	
Log likelihood	−28706.64		−5896.90		−17313.41		−12957.84		−13635.40		−4683.58	
LR $\chi 2$	391.16***		104.61***		286.73***		78.72***		81.63***		46.72	

Standard errors in parentheses.
*$p < .05$, **$p < .01$, ***$p < .001$.
Reference groups: female; age 62–64; no spouse, no children; weekday; education primary; income below average; living area city or suburb; country Austria.

via computer, but also have a higher probability of using this media than women. Thus, gender differences do not seem to relate primarily to the traditional vs. digital media distinction, but to the use of particular media platforms. These results align well with the first part of the hypothesis H2b, which argues that gender differences in time spent on digital media are modest.

Next, we further elaborate the interaction of age and gender. A significant interaction effect would indicate that the gender differences in given media use become larger or smaller as age increases. In Fig. 1, we present the marginal effects of gender by age on the predicted

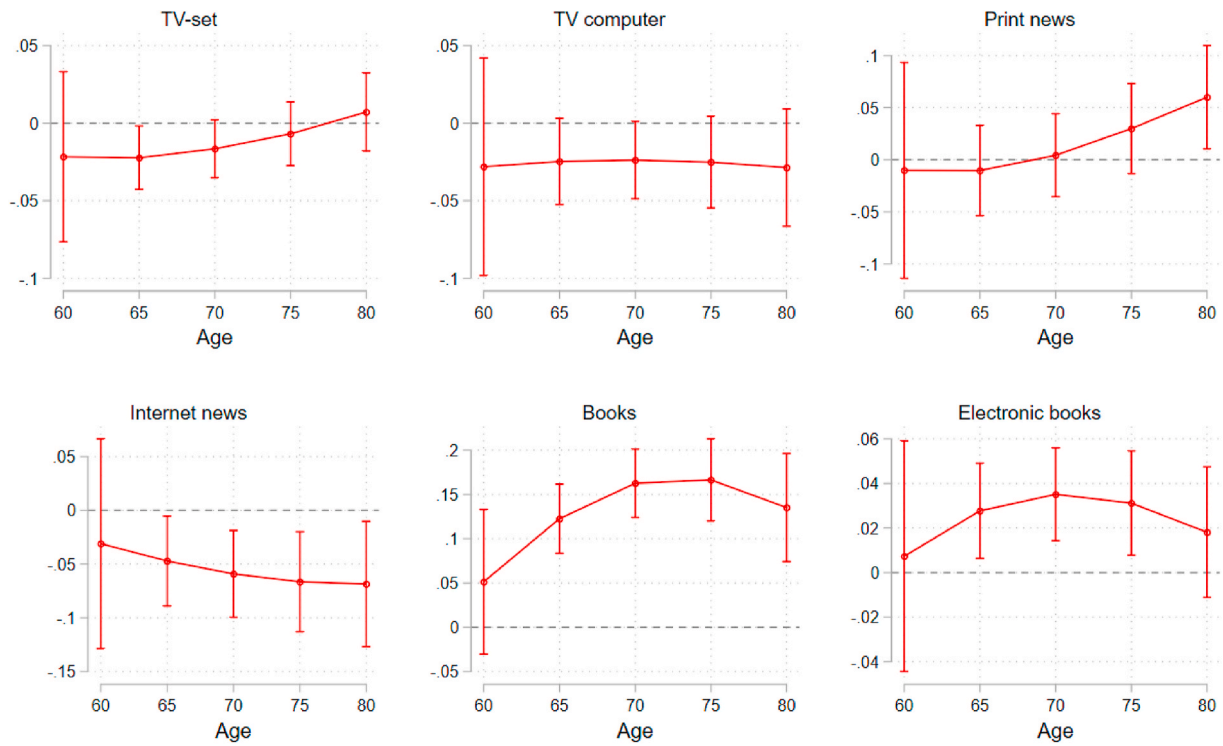

Fig. 1. Marginal effects of gender (male-female) on predicted probability (and 95% CI) of not using (zero-inflate) traditional and digital media use by age (quadratic).

probabilities of belonging to the group of media non-users. In Fig. 2, the same effects are presented for the predicted number of minutes.

Regarding traditional media use, the effect of gender varies depending on respondent age for all three media categories. For watching a TV set, gender differences among media non-users (Fig. 1) are significant only around the age of 65, after which the gender gap narrows. Similarly, but more pronounced, a decrease in gender differences is evident when looking at the time they spent on this media (Fig. 2). Men are more likely to watch a TV set and spend more time watching it, but these differences become smaller as respondents get older. For reading print news, we find a small gender difference for non-users of this media (Fig. 1), which concerns only the oldest segment of respondents. Men aged around age 80 or above are more likely to be print news readers than women of the same age. Regarding the reading of books, gender differences are the most tangible, and they increase as respondents get older. As Table 3 already showed, women are clearly

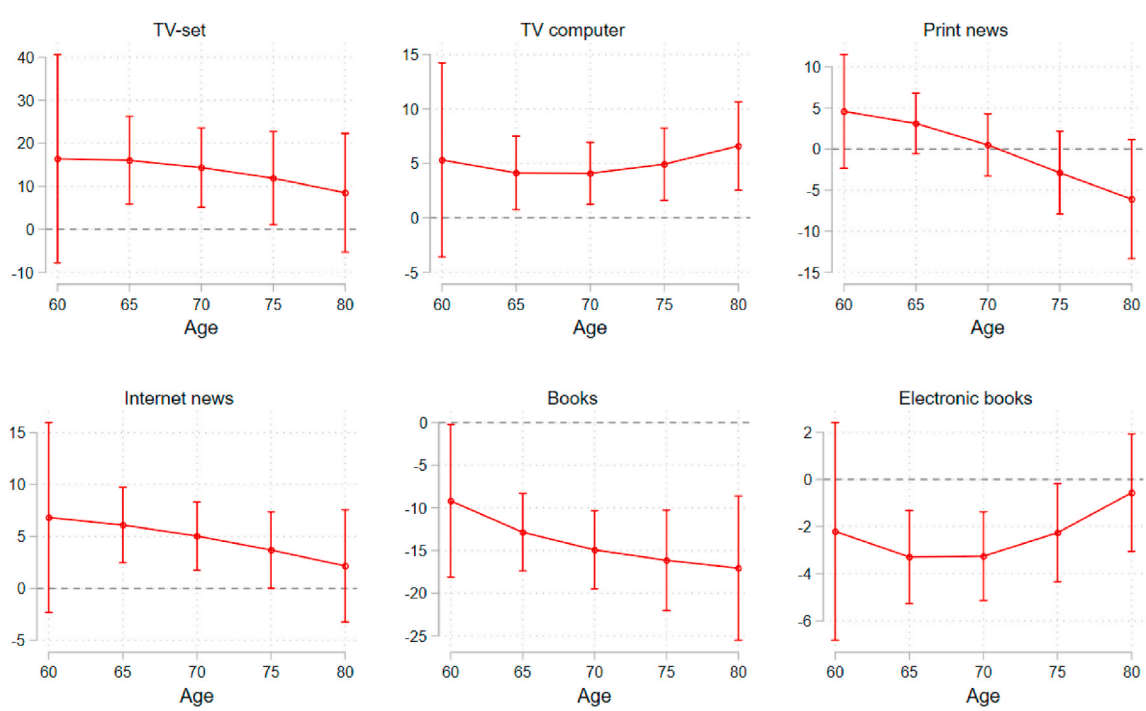

Fig. 2. Marginal effects of gender (male-female) on predicted number of minutes (and 95% CI) of time spent on traditional and digital media use by age (quadratic).

more likely to read books (Fig. 1), and they spend more time on reading books (Fig. 2) than men of the same age. Hence, our findings support hypothesis H2a, as gender differences in the time spent on traditional media are relatively small, and they do not systematically increase with age. An exception is the time spent reading books, which increases with age in favour of women.

There are also some interesting interactions between age and gender regarding the use of various digital media platforms. First, there is a significant difference in watching TV via computer, but only regarding time use (Fig. 2). Men watch TV using a computer more than women, and this gender gap increases with respondent age. Second, men are more likely to engage in reading news on the internet than women. This gender difference emerges around age of 65 and is quite stable across the respondents older than that (Fig. 1). Men also spend more time on this activity than women, but the gap decreases with age and is no longer significant around the age of 75 (Fig. 2). Third, we find that the gender difference regarding the use and time spent on electronic books are quite opposite to two other forms of digital media, but similar to those concerning the reading of printed books. Women are more likely to engage in this activity than men (Fig. 1) and women also spent a bit more time on it (Fig. 2). These gender differences are, however, significant only for the middle of the age spectrum and diminish among the oldest respondents. To sum up, our findings largely confirm the first part of hypothesis H2b presenting that the gender differences in time spent on digital media are relatively modest. However, we did not find evidence that these differences would become more acute with respondent age as the latter part of the hypothesis suggested.

4.3. Large but inconsistent country differences

In Figs. 3 and 4 we present the predicted probabilities of belonging to a group of media non-users and estimated time use by country separately for each media in respective order. The figures show results quite the opposite to the first part of hypothesis H3; there are considerable country differences in respondents' media use. These country differences do not seem to follow any clear pattern and vary in strength depending on the media.

For traditional media, country differences are small regarding non-users of TV sets and books (Fig. 3). The share of respondents not reading print news is slightly higher in Romania compared to the other countries. Country differences are larger for reading print news. The share of non-users of print news is highest in Romania, Canada, and Spain. Similarly, country differences in time spent on traditional media (Fig. 4) vary widely depending on the media and, interestingly, follow a reversed pattern from the share of non-users. Time spent on reading books does not differ among countries, but for watching TV sets and especially for reading print news we find larger differences. Canadian respondents spend more time watching a TV set than respondents from Spain, Austria, and Finland. By contrast, the time devoted to reading print news was highest in Austria, followed by the Netherlands and Finland.

For digital media, different patterns arise. The share of non-users (Fig. 3) of TV via computer was slightly higher in Canada and Romania than in other countries. Similarly, the share of non-users of internet news was higher in Austria and Romania than in the four other countries. Electronic books were used least often in Finland and Romania. As with traditional media use, the country differences in time spent using digital media (Fig. 4) follows an inverted pattern compared to the share of non-users. Time spent watching TV via a computer is clearly highest in Austria and lowest in Romania. Spain, in turn, scores higher than other countries in time spent reading internet news and electronic books. Concerning the latter, Finland and Romania registered the lowest levels of usage.

For the latter part of H3, we examined the country differences by respondent age. Fig. 5 presents predicted probabilities of belonging to the non-user group. Concerning media non-users, we find evidence of both an increase and decrease in country differences as respondent age rises. The modest country differences in the probability of never watching TV decrease as we move to older age groups. A similar process of shrinking differences appears for the probability of not reading electronic books. By contrast, for the probability of not reading printed books, we see a slight increase in country differences along with the age

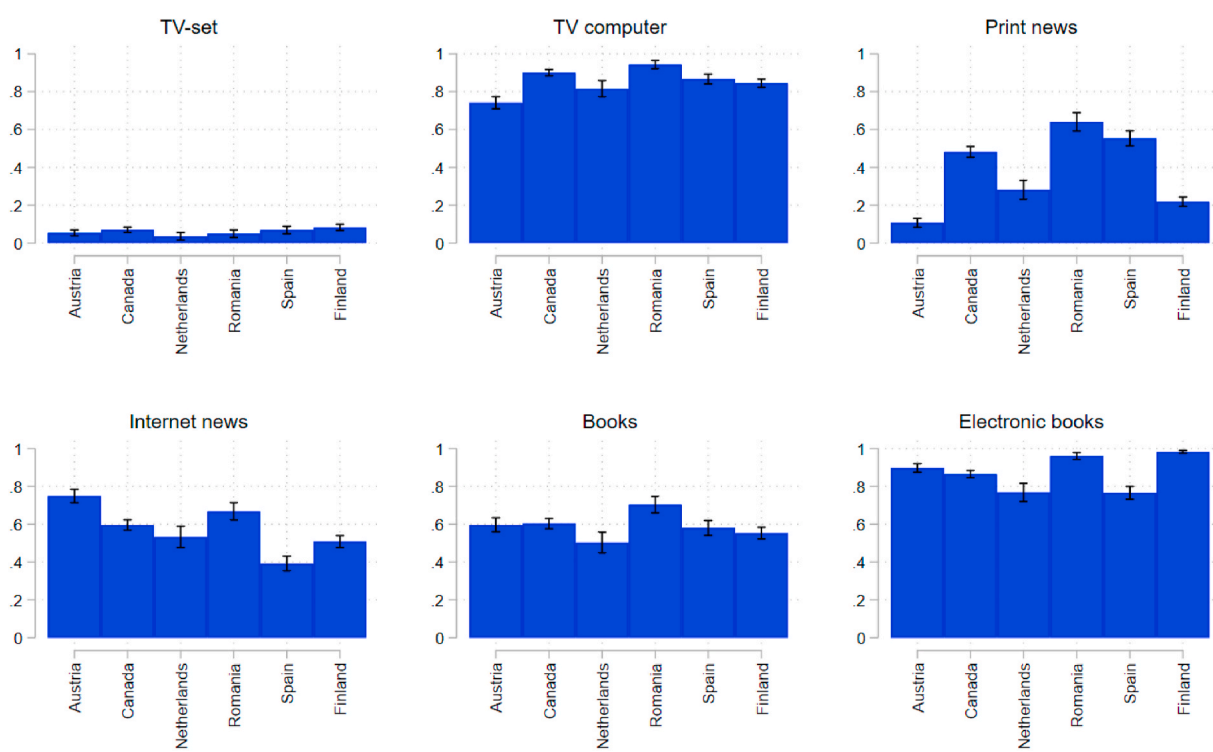

Fig. 3. Predicted probability (and 95% CI) of not using (zero-inflate) traditional and digital media by country.

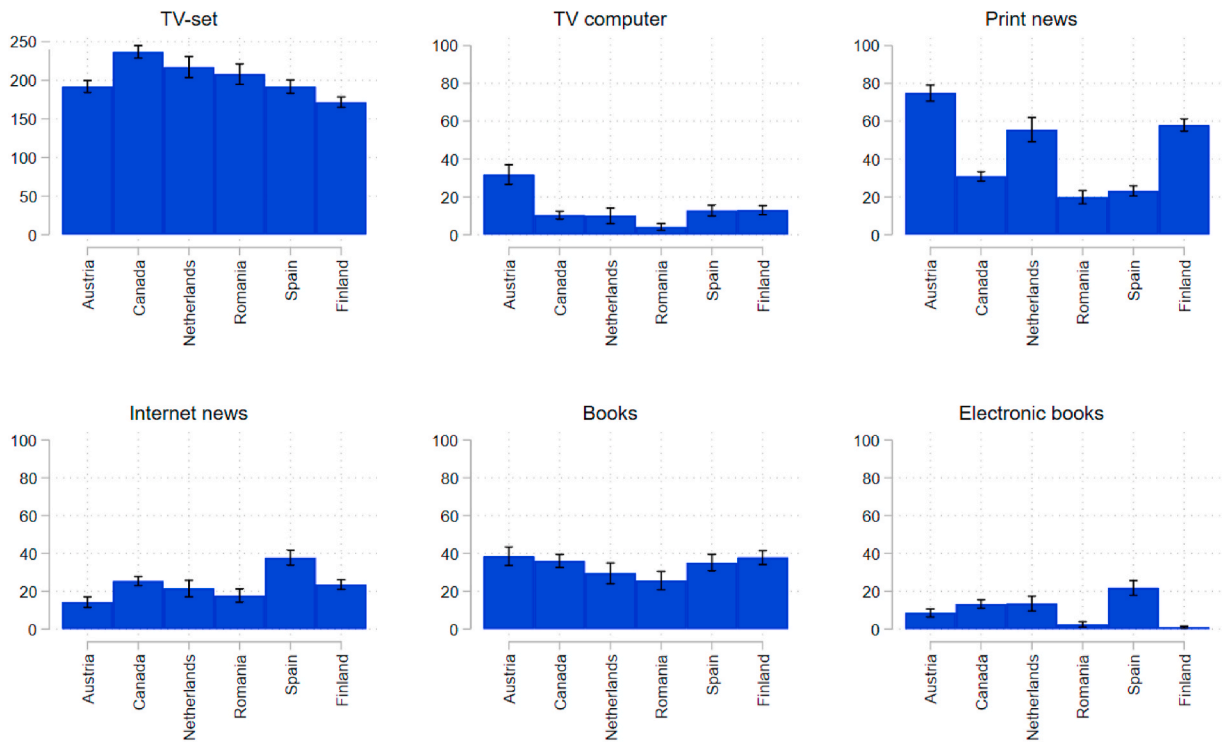

Fig. 4. Predicted number of minutes (and 95% CI) of time spent on traditional and digital media use by country.

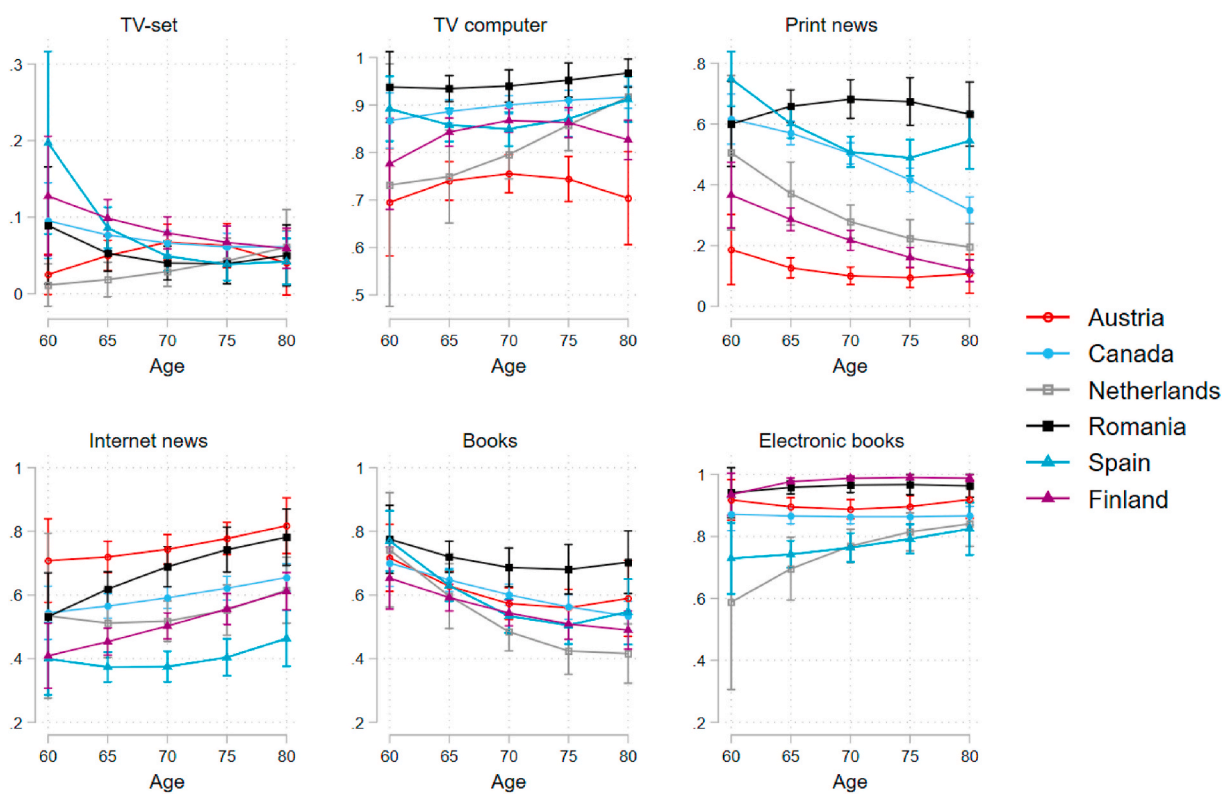

Fig. 5. Predicted probability (and 95% CI) of not using (zero-inflate) traditional and digital media by age (quadratic) and country.

of respondents. Country differences are largest regarding the probability of not using print and online news media. A clear decrease in non-readers of print news by age is evident for all countries, except for Romania, and is smaller for Spain than the other countries. For internet news, we found the opposite trend; the older the respondents are, the likelier they are to be non-readers of internet news. This trend is quite similar across the six countries.

Fig. 6 illustrates that the country differences in time spent on various media seem mainly to increase along with the age of respondents. Country differences are largest regarding traditional media, especially

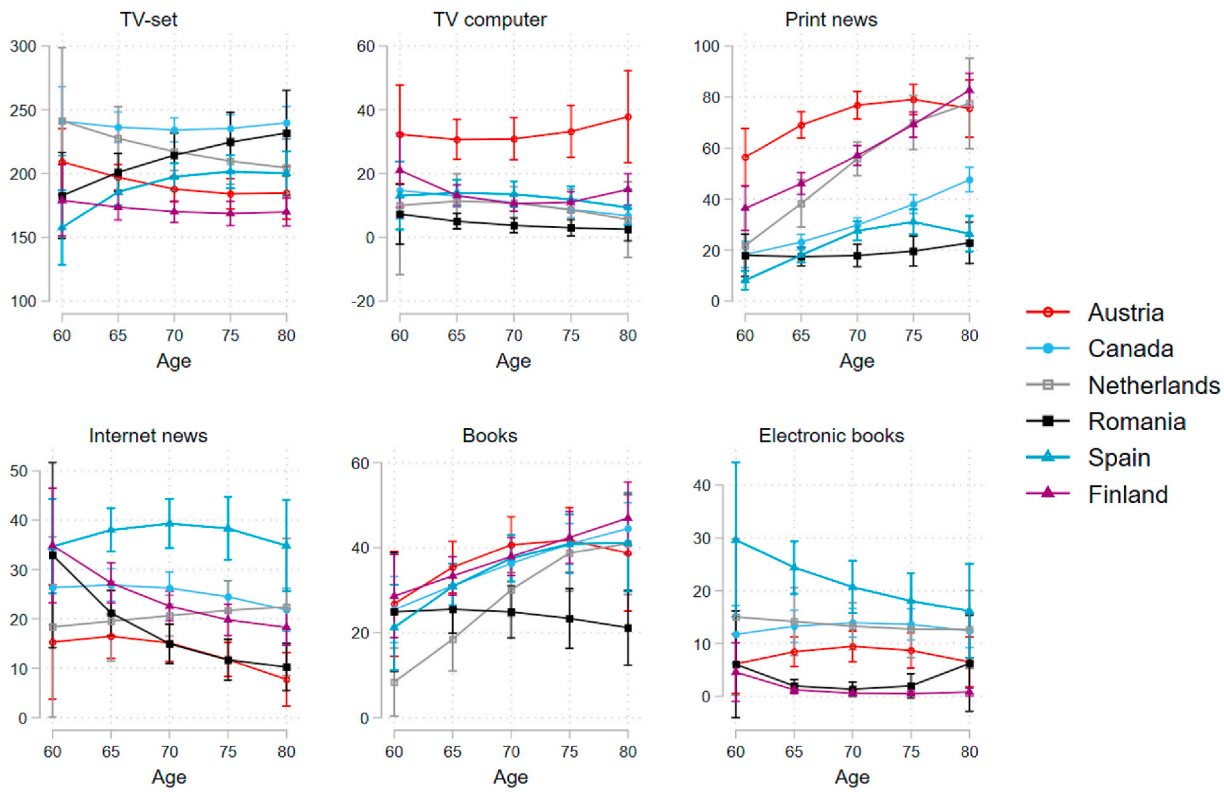

Fig. 6. Predicted number of minutes (and 95% CI) of time spent on traditional and digital media use by age (quadratic) and country.

watching a TV set and reading print news. The amount of time spent on watching a TV set is stable or decreases slightly as people get older in most countries, except for Spain and Romania, which show an increasing trend. For reading print news, we see the opposite development; time use increases with age in all other countries except Spain and Romania. Regarding the use of all other media types, country differences are smaller and trends more mixed. It is worth noticing, however, that Romanian respondents' media use has some quite distinct features compared to all other countries. This may be due to a lower adoption rate of digital media technologies and the use of a different sampling method. To sum up, our results suggest rather large country differences in the use of both traditional and digital media, which are not very stable across respondents of different age. Hence, hypothesis H3 is rejected.

5. Discussion and conclusions

The tenability of the aged heterogeneity thesis in connection to older adults' media use in six countries was tested using a large international data set. Regarding our main research question, whether heterogeneity in traditional and digital media use increases with age, our results speak of more detailed and media-specific connections between media use and age. In general, the results provide more support for aged heterogeneity in the use of digital media, while the use of traditional media platforms seems to become rather more homogenous with respondent age. This homogeneity in traditional media use may in fact be an indication of the oldest respondents' great generational attachment to print and other traditional media [40,44]. In addition, the high stability of traditional media's user interfaces may also be an advantage for older users if they experience sudden changes in functional ability. This implies that the concept of aged heterogeneity should be used with caution in relation to older internet users, who have developed some widespread and long-lasting relationship with older media platforms.

Second, we examined to what extent gender is related to the heterogeneity of media use among older internet users. Those few gender differences that we were able to identify were either small or modest, and unlike the aged heterogeneity thesis would suggest, gender differences did not become more accentuated with respondent age. In some rare activities, like reading electronic books, gender differences even disappeared among the oldest respondents. In this regard, our results are in line with studies arguing for shrinking gender difference in ICT use [13,35]. However, it may well be that digital technology use other than for the recreational purposes addressed here involve more gendered patterns and reflect other structural inequalities than those related to time use [10,24,38]. In terms of the aged heterogeneity thesis, our results imply that gender differences do not considerably add to the heterogeneity of older people's media use. Lastly, we investigated the role of country context in the heterogeneity of media use in later life. While previous studies indicated rather small country differences, we found sizable differences, which were media specific. We did not find, for example, that older adults in individualist countries (e.g., Finland and Canada) or Central Europe (e.g., Austria) would systematically use more digital media than people in Southern Europe (e.g., Spain; cf. [39,40]). Only Romania stood out from the other five countries with a clearly lower level of media use. The most systematic trend we found was that in countries where older adults' probability of not using a certain media is low, the respondents using that media spend comparatively more time on it. This verifies that as media diffusion proceeds among the older population, it also leads to increased time use. Based on these findings, we suggest that aged heterogeneity unfolds differently in different countries depending on their current phase of digitalisation and the particularities of their media consumption culture. The discovered country differences and country-specific media use patterns require further investigation that takes better into account the local context of media use.

6. Limitations and implications for future research

The sample we analysed included only older internet users, who certainly belong to the technology vanguard of their own age cohorts. In particular, the oldest respondents are a highly select group of internet

users. Hence, the sample does not represent the entire older population or those older adults who actively use other digital technology but not the internet. Another clear limitation relates to the cross-sectional approach, which does not allow for distinguishing age, generation, and period effects from one another. When the next wave of the panel data has been collected, it will be possible to study the changes in media use that occur on the individual level as people age. Future research should also analyse other media platforms and personal communication technologies to further test the feasibility of the aged heterogeneity thesis.

Author statement

Sakari Taipale: Conceptualization, Investigation, Writing - Original Draft, Writing - Review & Editing, Project administration, Funding acquisition Tomi Oinas: Conceptualization, Methodology, Formal analysis, Investigation, Writing - Original Draft, Writing - Review & Editing, Visualization Joonas Karhinen: Resources, Data Curation, Investigation, Writing - Original Draft.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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