Trends and heterogeneity in the use of eContacts in Denmark: A register-based study from 2005 to 2019

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Background

eContacts are a form of communication between doctor and patient in which physical and temporal co-presence is not required (Grønning et al. 2020). This includes email communication between patients and doctors in outpatient setting, renewing prescribed medications, and exchanging short messages via email, encrypted websites, and mobile applications (Sahl Andersen et al. 2011). Most studies on eContacts have mainly focused on qualitative analyses of general practitioners´ (GPs) and patients' expectations and experiences of eContacts in small and selective GP medical offices (e.g. Assing Hvidt et al. 2020; Banks et al. 2018; Bergmo et al. 2005; Cook et al. 2016; Dash et al. 2016; Hsu et al. 2005; Kristiansen et al. 2023; Liederman et al. 2005; Lin et al. 2005) The findings suggest that web messaging or email correspondence can reduce physicians' time expenditure by decreasing the number of phone calls needed to reach patients, increase patient satisfaction, and reduce the number of office visits (Banks et al. 2018; Bergmo et al. 2005; Liederman et al. 2005; Lin et al. 2005; Patt et al. 2003). A negative aspect of the eContacts were related to a need to arrange a follow-up appointment (Banks et al. 2018).

Literature on patients' characteristics associated with a higher use of eContacts is scarce. Based on the online Citizens and Information Communication Technology for Health survey, Newhouse et al. analyzed socio-demographic characteristics of eContacts users in 14 European countries, each with 1,000 respondents (Newhouse et al. 2015). Higher use was associated with younger age (16-24 years), being men, higher education, poor self-rated health, and multimorbidity (Newhouse et al. 2015). These findings are consistent with the study by Cook and colleagues, who surveyed 833 patients at the Princess Margaret Cancer Center in Canada (Cook et al. 2016). They found also that higher income was associated with a higher use of eContacts (Cook et al. 2016). In addition to patient characteristics, also physicians' characteristics, such as older age, more senior clinical position and a higher patient volume, were linked to a higher eContact use (Cook et al. 2016). A study based on Dutch electronic health records in 2018 found that eContact users were older and more likely to have hypertension, diabetes, or depression (Huygens et al. 2018). By utilizing data from 36 practices in a pilot project in South West England, Edwards and colleagues found that being women and in working age (25-64 years) were associated with a higher use of eContacts. In addition, week

days and times of the day when most people work (7:00am until 16-59pm) were associated with a higher volume of eContacts (Edwards et al. 2017). A systematic review of 57 studies conducted by Mold et al. revealed inconsistent findings regarding gender and age but confirmed that higher family income and employment were associated with greater use of eContacts (Mold et al. 2019).

While these studies have generated valuable insights, the evidence on individual characteristics of eContact use remains limited, making it unclear whether the observed patterns in eContact use reflect actual trends or are artifacts of small sample sizes and survey design. Moreover, prior research suggests that physicians' personal preferences may influence the provision of such services in non-mandatory settings, which may produce additional bias and limit the generalization of the study findings (Patt et al. 2003). Thus, large-scale population-based studies are needed to examine long-term developments and identify individual-level determinants of eContact use. Danish data represent a unique data resource to address/fill this research gap.

In Denmark, secure email communication between patients and doctors was first introduced in 2003 (Assing Hvidt et al. 2020; Grønning et al. 2020). It is mainly intended for communicating test results, renewing prescriptions, and exchanging short yes/no messages (Assing Hvidt et al. 2020). Qualitative studies also revealed that patients use email communication to discuss socio-emotional or sensitive topics (Assing Hvidt et al. 2020; Grønning et al. 2020).

Together with Estonia and Spain, Denmark has been recognized as a leader in digital health in Europe (Thiel et al. 2019). To illustrate cross-country differences, Thiel et al. developed the digital health index, which captures 34 indicators across three dimensions: policy activity, technical readiness and data integration, and actual use and exchange of data. Indicators include, for example, national funding for digital health, electronic exchange of health data, or ePrescription in pharmacies, physicians' practices and hospitals (Thiel et al. 2019). Each indicator is assessed on a five-point scale from "fully applies" to "does not apply" (Thiel et al. 2019). Denmark, with more than 20 years of experience in digital health, fulfils around three-quarters of these indicators, including data security standards and a universal national patient identifier (Thiel et al. 2019). Since 2007 Denmark is a champion country in Europe with the highest eHealth utilization (Santana et al. 2010) with 50% of respondents reporting that they already contact their physician, nurse or healthcare organization by email (Newhouse et al. 2015).

The availability of such comprehensive data, combined with Denmark's pioneering role in digital health, makes the country an excellent setting for examining long-term trends and individual-level determinants of eContact use. Against this backdrop, we address the following research question: What are patients' characteristics associated with eContact use and how have these patterns evolved over time?

Methods

Study population

This study utilized register data that contain a wide variety of characteristics for all Danish residents, including demographic characteristics and eContact use covering the years 2005 to 2019. Although data are available from 2003 onwards, we start our observation period in 2005, as only a small number of eContacts were recorded in the first two years following their introduction, making it impossible to analyze the characteristics under consideration. Furthermore, we assume that the COVID-19 pandemic substantially altered the use of eContacts, and therefore we restrict our observation period to the years prior to the pandemic.

Data on eContacts were obtained from the National Health Service Register (NHSR) (Sahl Andersen et al. 2011; Thygesen et al. 2011).The NHSR contains information on primary care and provides information on the provider and the provided services via a six-digit code. This coding allows for differentiation between in-person contacts, phone contacts, and eContacts. In 2003, email was introduced as a mode of communication and became mandatory for all general practitioners in 2009 (Assing Hvidt et al. 2020). In January 2019, the mobile application *My Doctor* was launched. Regardless of the medium through which services are provided—whether via email or a mobile application—they are recorded under the same codes in the register. Therefore, the term eContacts is used as a collective designation for these interactions.

Our study focuses on contacts with GPs as they act as gatekeepers for specialized treatment within the Danish healthcare system. The sample comprises the total number of contacts, by mode (phone, in-person, and eContact), for each individual aged 15 years and older residing in Denmark during each year of the observation period, provided they had at least one contact with a GP in that year, irrespective of the communication mode. The restriction to individuals aged 15 and above reflects the definition of adulthood within the Danish healthcare system. Observations with missing values for education and income were excluded from the analysis (N = 249,059). The final sample includes 5,483,664 individuals with a total of 709,835,094 contacts with GPs of which 50,137,063 were eContacts.

Using the Civil Personal Register (CPR) number, we linked data from the Central Population Registry (CPR), the Population Education Register (PER), and the Income Statistics Register (ISR) to obtain information on sociodemographic characteristics such as age, gender, the highest completed level of education, marital status and migration background (Baadsgaard and Quitzau 2011; Jensen and Rasmussen 2011; Schmidt et al.

2014; Thygesen et al. 2011).

Age is categorized into ten-year age groups, with the exception of the youngest group, which includes individuals aged 15 to 29, and the oldest age group, which comprises individuals aged 80 years and older. Migration background is classified as natives, first-generation migrants, and second-generation migrants. Education is operationalized as the highest completed level of education, categorized into low, medium, and high based on the International Standard Classification of Education (ISCED 2011). Levels zero to two are defined as low education, levels three and four as medium education, and levels five to eight as high education (Eurostat). Income is measured as disposable income after tax and interest expenses plus the calculated rental value of owner-occupied housing. Gender- and year-specific income tertiles are then calculated on this basis. In addition, gender and marital status are included, using the categorization provided in the CPR.

Analytical approach

To examine trends in the use of eContacts, we calculated the number of eContacts with GPs for each individual in the respective year of the observation period. We then analyzed how different social characteristics are associated with the number of eContacts and how these trends change over time. In order to obtain a dataset that could be analyzed using the available resources, the data were converted into a wide format for each year. This resulted in a dataset of 57,501,885 observations.

This register-based longitudinal cohort study focuses on repeated observations of count data. The distribution of eContacts shows a large proportion of zeros and considerable overdispersion, and eContacts are observed repeatedly for the same individuals throughout the observation period. To account for the nature of the data, we employed negative binomial mixed-effects regression. Standard negative binomial regression models are commonly used to analyze overdispersed count data, where the variance exceeds that of a Poisson model. In a Poisson model the variance equals the mean. Therefore, overdispersion refers to additional variability beyond the mean. We further included a random intercept for individuals to account for the dependency of observations over time and for individual differences in the use of eContacts. Interaction effects for gender, migration background, and education are calculated with time, shown as marginal predicted mean, in order to assess developments over time while holding all other variables constant at their mean.

Data preparation, descriptive analyses, and visualization of the results were conducted in R (version 4.4.1) and regression models were estimated in STATA (version 19.5).

Results

Figure 1 displays individuals' average number of eContacts between 2005 and 2019 by gender and age group. The average number of eContacts increased among women and men across all age groups over the entire time period. The strongest increase is observed among the oldest age group 80+ from 2010 onwards. This is also the only age group in which the trend declines again in 2018. In that year, the average number of eContacts was 3.6 for women and 2.7 for men, and it decreased to 3.4 for women and 2.5 for men in 2019.

Gender differences in the utilization of eContacts widened in all age groups up to the age of 60 with women having consistently higher average number of eContact. This gap is most pronounced in the age group 30-39, with an average of 2.2 eContacts for women compared to 0.9 for men in 2019. For the age groups 60 to 69 and 70 to 79, the increasing trend is similar among men and women. In the 60 to 69 age group, the gender gap in the average number of eContacts emerges in 2013 and amounts to 0.3 average eContacts in 2019. In the 70 to 79 age group, men had a slightly higher average number of eContacts between 2006 and 2016. After 2016, no gender difference in the average number of eContact was observed.

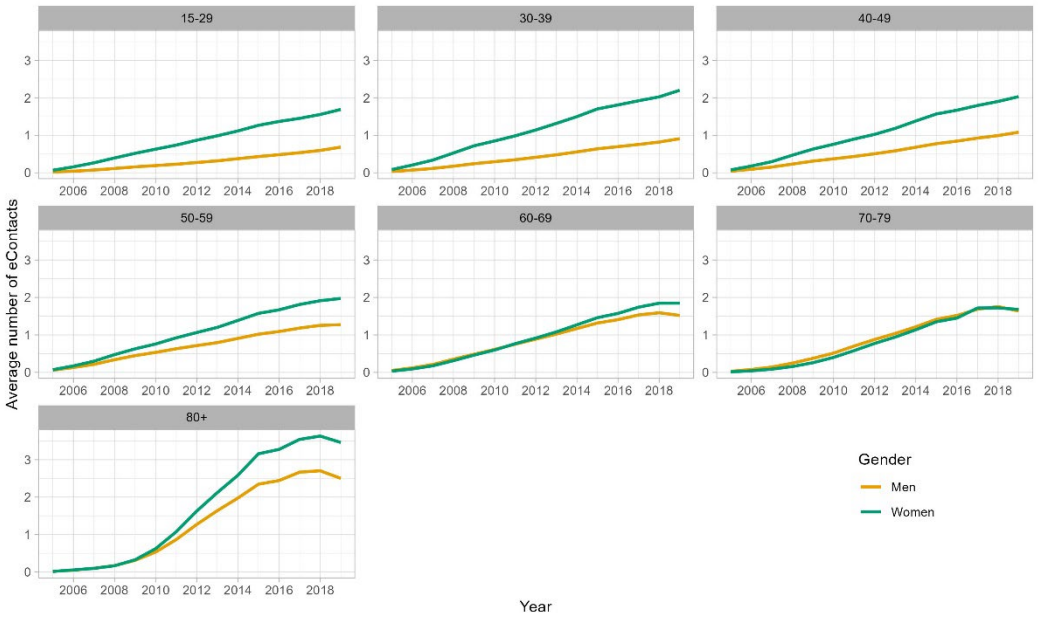

Figure 1: Average Number of eContacts by Age and Gender (2005-2019)

Table 1 presents the results from the negative binomial regression analysis, reported as incidence rate ratios (IRR). We found a significant temporal trend, with each additional year being associated with a 24.7% increase in the incidence rate of eContact (IRR = 1.247, 95% CI: 1.246-1.247). Gender was significantly associated with the number of eContacts, with men

exhibiting a 52.5% lower incidence rate compared to women (IRR = 0.474, 95% CI: 0.473-0.476). Age was negatively associated with the number of eContacts. Compared to individuals aged 15 to 29 years, 70- to 79-year-olds had the lowest level of eContact use (IRR = 0.752, 95% CI: 0.749-0.756). However, the incidence rate among individuals aged 80 years and older (IRR = 1.60, 95% CI: 1.590-1.610) exceeds that of the youngest age group by far.

Marital status was also related to the number of eContacts. Compared to single individuals, widowed individuals exhibited a 21.9% higher incidence rate (IRR = 1.219, 95% CI: 1.212-1.226), while the differences among married (IRR = 1.008, 95% CI: 1.005-1.012) and divorced (IRR = 1.057, 95% CI: 1.053-1.062) individuals relative to the reference group were small. Migration background was strongly associated with lower incidence rates of eContacts. First-generation migrants had a 40.7% lower incidence rate compared to native-born Danes (IRR = 0.593, 95% CI: 0.590-0.597), and second-generation migrants had a 51.5% lower rate (IRR = 0.485, 95% CI: 0.479-0.491), indicating a lower usage consistent across generations.

Higher educational attainment and income were both associated with an increased number of eContacts. Compared to individuals with low education, those with medium (IRR = 1.351, 95% CI: 1.347-1.356) and high education (IRR = 1.578, 95% CI: 1.574-1.583) had 35.1% and 57.8% higher incidence rates. Similarly, compared to individuals with low income, those in the medium-income (IRR = 1.131, 95% CI: 1.128-1.133) and high-income (IRR = 1.162, 95% CI: 1.159-1.165) tertiles had 13.1% and 16.2% higher incidence rates, respectively. Finally, the variance components suggest that individual differences (ID variance = 2.477) account for a substantial proportion of variability in the number of eContacts.

Figure 2 shows the coefficients for the interactions between time and gender, migration background, and education as marginal predictions. All other variables are held constant at their mean. The results indicate that the expected average number of eContacts increases for both men and women over the observed period, with the increase becoming larger over time. The gender differences also widen, reaching a difference of two average eContacts between women and men in 2019.

Table 1: Results of negative binomial mixed effects regression model

Variable	Number of eContacts IRR (95% CI)
Intercept	0.046 (0.046 to 0.047)
Year	1.247 (1.247 to 1.247)
Gender	
Women (ref.)	-
Men	0.475 (0.473 to 0.476)
Age	
15-29 (ref.)	-
30-39	0.928 (0.925 to 0.931)
40-49	0.873 (0.870 to 0.876)
50-59	0.853 (0.849 to 0.856)
60-69	0.797 (0.794 to 0.801)
70-79	0.752 (0.749 to 0.756)
80+	1.600 (1.590 to 1.610)
Marital Status	
Single (ref.)	-
Married	1.008 (1.005 to 1.011)
Divorced	1.057 (1.053 to 1.062)
Widowed	1.219 (1.212 to 1.226)
Migration Background	
Natives (ref.)	-
1st Generation	0.593 (0.590 to 0.597)
2nd Generation	0.485 (0.479 to 0.491)
Education	
Low (ref.)	-
Middle	1.351 (1.347 to 1.356)
High	1.578 (1.574 to 1.583)
Income	
Low (ref.)	-
Middle	1.131 (1.128 to 1.133)
high	1.162 (1.159 to 1.165)
Number of Observations	57,501,885
Number of Groups	5,483,664
Variance Individual	2.477
Alpha	0.223

The mean predicted number of eContacts increased also across all migration groups. The largest increase was observed among native-born, who reach a mean of 3.5 eContacts in 2019. The annual increase is the same for first- and second-generation migrants, although first-generation migrants show slightly higher levels of use. In 2019, first generation migrants have a mean predicted number of 2.11 and second-generation migrants of 1.80 eContacts. In contrast to the trends for gender and migration background, the differences between education levels decreased between 2015 and 2019. Individuals with higher education consistently show the highest usage, followed by those with medium education, while individuals with lower education report the lowest usage. In 2019, there is no difference between those with high and medium education, and individuals with low education also report only slightly lower usage. In that year, all three groups reach a mean expected number of approximately 3.4 eContacts.

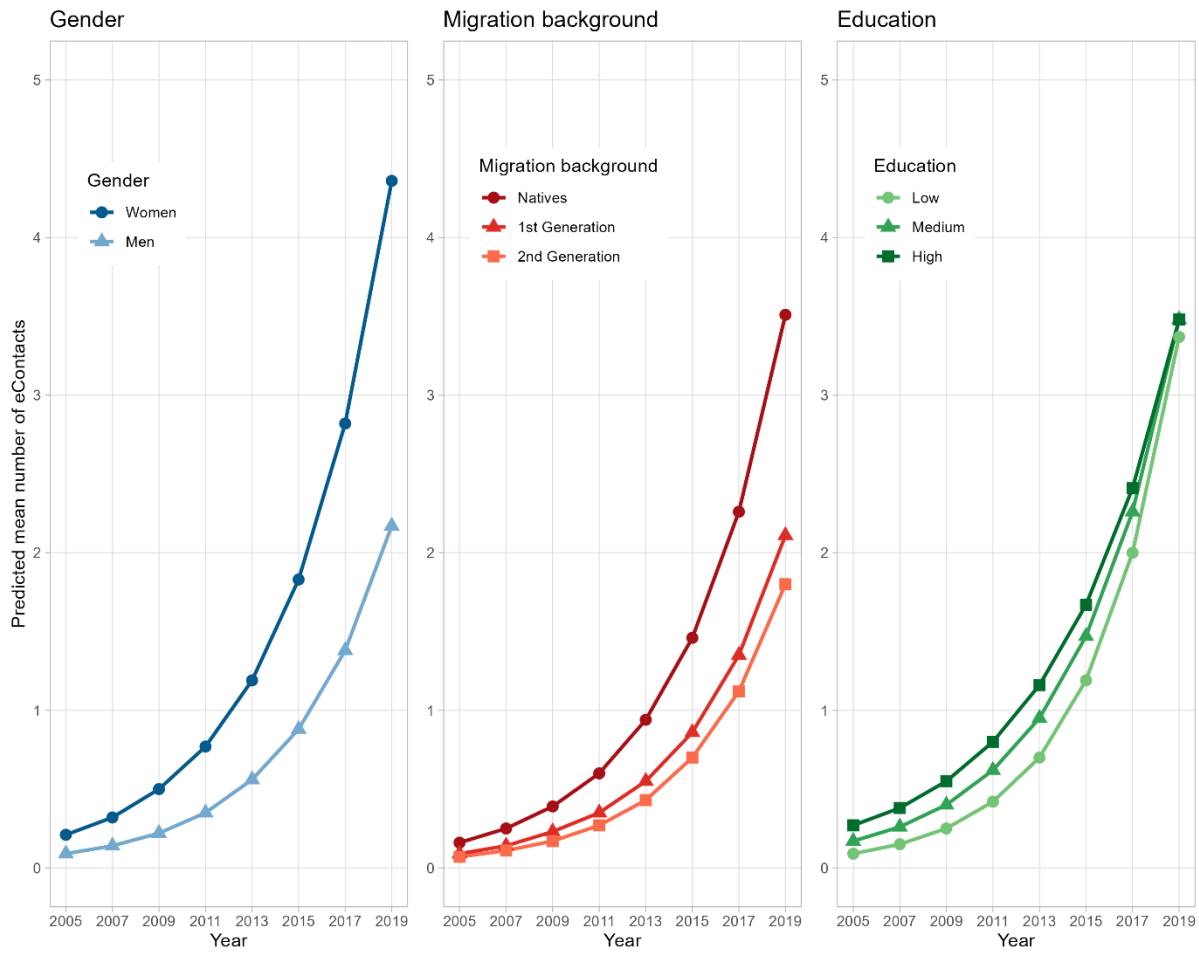

Figure 2: Predicted annual eContacts per person

Discussion

In the present study, we investigated diversity in the use of digital communication modes, eContacts, in the primary care setting among individuals aged 15 years and older in Denmark in the time period from 2005 to 2019. Our findings indicate significant sociodemographic disparities in eContact use. Men were less likely to use eContacts than women, while older age groups had a lower usage compared to younger adults. One exception was the oldest age group of individuals aged 80 years and older, who had a 60% higher incidence rate of eContact use compared to individuals aged 15 to 29. High education and income were positively associated with eContact use, suggesting that individuals with higher socioeconomic status may have greater access to and/or familiarity with eContacts. Migration background also played an important role, as first- and second-generation migrants exhibited lower rates of eContact utilization compared to native Danes.

Using a mixed-effects approach enabled us to control for the dependency of observations over time as well as for individual differences in the use of eContacts. This adjustment is important, as our variance component for individuals indicates a significant effect of individual differences on eContacts use. Such differences may reflect personal preferences in the use of digital devices and in overall internet use. The observed gender gap, particularly among younger age groups, could be explained by the use of oral contraceptives. For such medications, once an appropriate drug has been identified, a physical visit is often not required, and an eContact may therefore be sufficient. Furthermore, the observed gender gap is consistent with existing literature on gender differences in internet use for health purposes (Andreassen et al. 2007; Kummervold et al. 2008; Tennant et al. 2015; Zanaboni and Fagerlund 2020). It may also reflect broader gender differences in treatment-seeking behavior with women have a higher number of doctor's visits at all ages (Courtenay 2000; Höhn et al. 2020; O'brien et al. 2005; Robertson 2006; Thompson et al. 2016). The widening of this gap over time may suggest that the introduction of eContacts has reinforced existing patterns of health-seeking behavior.

The observed age-related patterns correspond to official statistics from the Danish Organization of General Practitioners (PLO), which report that individuals aged 80 years and older are the most frequent users of eContacts (PLO 2019). According to the PLO, this can be explained by the greater complexity of health conditions at advanced ages, which require more frequent assessments, follow-up, and coordination. Also, many older adults are residing in nursing homes where staff may initiate eContacts on their behalf (PLO 2019). Having the data at hand in this study we were unable to identify the place of residence and encourage health scholars to further investigate reasons underlying such a high eContact use at the oldest ages. Additional explanations may include age-related hearing and vision loss, as eContacts provide a means to consult a GP despite such barriers (Bavngaard and Grønning 2021).

Differences by education and income are consistent with prior research on eContacts and eHealth use more broadly (Cook et al. 2016; Kontos et al. 2014; Newhouse et al. 2015). These patterns may be explained by disparities in individuals´ skills in using digital technologies for health purposes, often referred to as eHealth literacy [ref]. Research findings demonstrated a positive association between higher education, higher income, and eHealth literacy (Estrela et al. 2023). The decreasing differences in eContacts use by education level over time may reflect a reduction in overall disparities in digital competence with the population, which has been identified as a key factor in the utilization of eHealth services (Lee and Tak 2022). Moreover, eHealth literacy and digital competence may also help to explain the differences observed between native-born Danes and individuals with a migration background. Nevertheless, the only slight difference between first- and second-generation migrants, however, is unexpected and warrants further investigation.

Strength and limitations

Our study is the first descriptive information on the trends in the eContact use in the entire national population in Denmark and is the first study to assess social patterning of eContact use at the population scale. However, the register does not provide information on the content of the contacts. Therefore, it is not possible to determine whether an eContact was for preventive or continuing treatment. Certain chronic conditions, such as hypertension or diabetes, may be associated with higher usage among patients and GPs, which we could not investigate with our data (Huygens et al. 2018). Furthermore, our definition of eContacts is largely data driven. Potential differences in the utilization of email and mobile applications could not be observed. In addition, our findings may be limited to populations with healthcare systems comparable to that of Denmark, which is characterized by nationwide coverage and no out-of-pocket expenses for GP visits. Despite these limitations, our study makes an important contribution to the literature by examining differences in eContact use across sociodemographic groups and their development over time.

Conclusion

In this study, we found that women, individuals aged 80 years and older, those with higher education and income, and persons born in Denmark are the most frequent users of eContacts. The differences between women and men as well as between natives and migrants have widened over time. To ensure equitable access, greater emphasis should be placed on making eContacts accessible to all population groups. Efforts to reduce disparities in eHealth literacy may be a key step toward achieving this goal.

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