Digital disparities among healthcare workers in typing speed between generations, genders, and medical specialties: cross sectional study

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ABSTRACT

OBJECTIVE
To investigate the typing skills of healthcare professionals.

DESIGN
Cross sectional study.

SETTING
Two large tertiary medical centres in Amsterdam, the Netherlands.

PARTICIPANTS
2690 hospital employees working in patient care, research, or medical education.

MAIN OUTCOME MEASURES
Participants completed a custom built, web based, Santa themed, typing test in 60 seconds and filled out an associated questionnaire. The primary outcome was corrected typing speed, defined as crude typing speed (words per minute) multiplied by accuracy (correct characters as a percentage of total characters in the final transcribed text). Feelings towards administrative tasks scored on the Visual Analogue Scale to Weigh Respondents’ Internalised Typing Enjoyment (VAS-WRITE), in which 0 represents the most negative and 100 the most positive feelings towards administration, were also recorded.

RESULTS
Between 18 and 21 May 2021, a representative cohort of 2690 study participants was recruited (1942 (72.2%) were younger than 40 years; 2065 (76.8%) were women). Respondents’ mean typing speed was 60.1 corrected words per minute (standard deviation 20.8; range 8.0-136.6) with substantial differences between professions and specialties, in which physicians in internal medicine were the fastest among the medical professionals. Typing speed decreased significantly with every age decade (rho −0.51, P<0.001), and people with a history of completing a typing course were more than 20% faster than those who had not (mean difference 12.1 words (standard error 0.8), (95% confidence interval 10.6 to 13.6), P<0.001). The corrected typing speed did not differ between genders (0.5 (0.9) words, (~1.4 to 2.4), P=0.61). Women were less negative towards administration than were men (mean difference VAS-WRITE score 7.68 (standard error 1.17), (95% confidence interval 5.33 to 10.03). Of all professional groups, medical staff reported the most negative feelings towards administration (mean VAS-WRITE score of 33.5 (standard deviation 22.9)).

CONCLUSIONS
Important differences were reported in typing proficiency between age groups, professions, and medical specialties. Specific groups are at a disadvantage in an increasingly digitalised healthcare system, and these data could inform the implementation of training modules and alternative methods of data entry to level the playing field.

Introduction
Writing medical notes is an inevitable reality for all healthcare professionals. Much of this writing nowadays takes place in electronic health records, which facilitate an up-to-date, interdisciplinary overview of a patient’s medical information. Intelligent use of electronic health records can improve the quality of healthcare, and enable unprecedented linkage of health data, thereby aiding a nationwide research effort. Of course, use of electronic health records also avoids healthcare workers’ stereotypically illegible handwriting, which has the potential of leading to medical errors.

Despite, or perhaps because of, the introduction of electronic health records, healthcare professionals are faced with an ever increasing administrative workload. Physicians spend up to 50% of their day on administrative tasks in electronic health records, which leads to decreased job satisfaction, among many other effects. The large number of administrative tasks, including writing medical notes, in addition to a typically high pressure work environment, makes typing a vital skill for medical workers. However, almost nothing is known about the typing proficiency of the medical community. Physicians’ handwriting has been studied a handful of times since at least 1979, however, only one small scale study has assessed their typing skills. In a study of 104 medical residents from the USA, Kalava and colleagues reported a median typing speed of 36.3 words per min. For context, the average typist will generally manage 40-50 words per
min, while advanced typists can easily achieve more than 100 words per min.\textsuperscript{17}

The overall gap in knowledge in medical typing skills is in stark contrast with its potential importance because typing is now essential for a large proportion of daily tasks. A pilot study on British physicians even suggested that more time spent on writing notes might be associated with a reduction in emotional wellbeing and engagement in work.\textsuperscript{18} We sought to investigate the typing skills of the healthcare community in two large university hospitals in the Netherlands.

**Methods**

**Study design**

We used a custom built web based application to assess the typing speed among staff of the two hospitals that make up Amsterdam UMC, the largest academic medical organisation in the Netherlands. Data were collected over four days, between 18 and 21 May 2021. We used the hospitals’ human resource systems to extract demographic data on profession, gender, and age for our source population.

**Recruitment**

All employees of Amsterdam UMC could participate, however, we focused on staff working directly or indirectly in patient care, staff with medical administrative tasks, or people with tasks related to research or education. Respondents were invited in three ways: through an email to all employees working in the aforementioned areas; through an invite posted on the hospital’s digital bulletin board; and through banners posted at staff entrances to Amsterdam UMC’s main buildings. Before participation, respondents were informed about the fact that data were collected anonymously, that participation would take approximately three minutes of their time, and that they were encouraged to participate regardless of their self-perceived typing skills.

**Digital application**

After accessing the application through a URL on their own computers, respondents answered brief questions about their background, work, any formal typing training they might have had, and their administrative workload (supplementary materials 1). All questions were mandatory. After the questions, respondents were asked to copy as much as they could of the presented short story about Santa Claus in the time frame of 60 seconds (box 1, supplementary materials 1). The text was written in Dutch and measured 156 dictionary words occurring in the Van Dale Dictionary\textsuperscript{19} (755 characters excluding spaces, or 910 including spaces), containing 23 punctuation marks and 17 capitalised letters. The text to copy was shown only after the answers to the questionnaire had been locked into the dataset.

The typing test had a stationary cursor, through which the text moved from right to left (fig S1). The application showed the entire linguistic clause before respondents started to type said clause. Respondents could correct any errors within a word or in punctuation marks up to the moment of hitting the spacebar and starting a new word. Access from mobile devices was blocked. Data were saved automatically on completion of the 60 second time window.

**Outcomes and data processing**

The primary outcome measure was the corrected typing speed, defined as crude typing speed (words per minute) multiplied by accuracy (correct characters as a percentage of total characters in the final transcribed text). In line with international conventions,\textsuperscript{20} we defined a word as five characters including spaces for the purposes of our analyses. Hence, our analyses assumed the presented text to be 182 words. We also assessed self-reported gender, age categorised in decades, number of fingers used to type, details on formal training in touch typing, time spent on administration, and feelings towards administration. Feelings towards administrative tasks were measured on our newly developed Visual Analogue Scale to Weigh Respondents’ Internalised Typing Enjoyment (VAS-WRITE), an adaptation of the original Visual Analogue Scale used to quantify experiences such as anxiety or pain.\textsuperscript{22, 23} The VAS-WRITE ranges from 0 to 100, in which 0 represents the most negative and 100 the most positive feelings towards administration.

Evident outliers with highly improbable test results were excluded from analyses (eg, test results indicating technical difficulties). We defined an outlier as any attempt with an uncorrected speed of less than 10 words per min, or an accuracy of less than 50%. Notably, one respondent completed the full text of 182 words with an accuracy of 100%, approaching the world record reported at 212 words per minute,\textsuperscript{24} which prompted our suspicion that this respondent had cheated, even though the source text was not accessible. We removed this entry for our analyses, accepting the odds that we might have missed a valuable opportunity to call the Guinness Book of World Records. As our research focused on employees working in patient care, research, and education, we excluded any respondents not working in such areas. We also excluded all reattempts, which were labelled automatically by our webtool. Finally, various groups were clustered to enable statistical analyses (eg, specific professions or specialisations).

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**Box 1: Santa Claus themed paragraph for typing test**

Santa Claus sighs and sits down. His reindeer look at him sadly, he has been typing for weeks. He has to fill out a checklist for each present, and usually in triplicate. There is really no time for it. He just wants to make children happy and see that smile on their faces. Defeated, he strokes his full beard. They did not even mention this during his job interview. But what can he do? The use of elves has been prohibited by the occupational health service a long time ago. Suddenly, Santa jumps to his feet. He has made a resolute decision and shuts down his computer. No more unnecessary administrative tasks, only the bare necessities. It is like a weight has fallen off his shoulders. The days seem longer, the sun breaks through the clouds, birds have started chirping again. Born again, Santa Claus jumps on his sleigh. His reindeer rear out of happiness. The time has come to go back to doing what he is good at: helping people.

\textsuperscript{17}World Records. As our research focused on employees working in patient care, research, and education, we excluded any respondents not working in such areas. We also excluded all reattempts, which were labelled automatically by our webtool. Finally, various groups were clustered to enable statistical analyses (eg, specific professions or specialisations).

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**Statistical analyses**

We statistically analysed data using R version 4.0.4. Descriptive data were reported as mean (standard deviation), mean difference (standard error of the mean difference), and 95% confidence interval for continuous variables, median (interquartile range) for non-parametric data, and frequency (percentage) for categorical data. Non-parametric data were compared using a Wilcoxon rank-sum test. Correlation analyses were done with the R package psych, using Spearman’s rho ($\rho$) to quantify the associations between typing speed and VAS-WRITE score, time spent on administrative task, number of fingers used to type, and age group. We assessed the effect of age on typing speed by one way analysis of variance (ANOVA), and post-hoc, we used Tukey’s Honest Significant Differences to directly compare all age groups to each other. To correct for age in the typing speed comparisons between departments and between professions, we performed an analysis of covariance (ANCOVA) followed by Tukey’s Honest Significant Differences. To assess the impact of the different age and gender distribution between our respondents and the source population, we performed inverse probability of selection weights with the survey package. To assess the effect of age on typing speed after weighting, we used a generalised linear model (svyglm function), with the weighted typing speed as the dependent variable and age group as the independent variable. We subsequently used the glht function from the multcomp package to directly compare the weighted typing speed between all age groups. Statistical significance was defined as a P value of less than 0.05 throughout.

**Patient and public involvement**

Due to the nature of the study, no patients were involved. Respondents were not involved in the study design, its execution, or data analysis. Results will be communicated to respondents and all other hospital staff through the hospital’s internal bulletin board.

**Results**

**Response and respondent characteristics**

At the end of the four day, flash mob type of study, we collected 4164 unique attempts. We removed re-attempts ($n=1342$), people with incomplete

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![Chart](https://via.placeholder.com/150)

**Fig 1** | (Top panel) Treemap overview of all respondents, organised by profession and subsequent clustering ($n=2690$). The other medical workers category includes therapists and clinical technicians. Administrative workers include doctor’s assistants. (Bottom panel) Bubble plot of typing speed and VAS-WRITE score, clustered and coloured by professional group. Bubble size is proportional to the group size. The colour key is ordered by VAS-WRITE score. VAS-WRITE=Visual Analogue Scale to Weigh Respondents’ Internalised Typing Enjoyment.
questionnaires (n=4), any outliers (n=18), and respondents who were not in our target population (n=110), which resulted in the final dataset of 2690 test results.

Our study succeeded in capturing the breadth of Amsterdam UMC’s community, representing all healthcare, research, and education professions (fig 1, top panel), and all medical specialisations (fig 2, top panel). Most respondents were women (76.8%) and were younger than 40 years (72.2%); about half of all respondents (47.7%) had previously completed a typing course (table 1). The difference between the source population and the respondents was small but distributions were significantly different: our sample included more women and young people and laboratory personnel were somewhat underrepresented (table S1). Sensitivity analyses investigating the implications thereof are reported.

The mean crude typing speed of all respondents was 62.8 words per minute (standard deviation 20.6) with a mean accuracy of 95.2% (standard deviation 7.3). The mean corrected speed (hereafter: typing speed) for all respondents was slightly lower at 60.1 corrected words per minute (standard deviation 20.8; range 8.0-136.6).

Typing speed and feelings towards administration
Initially, we focused on the different professions that were represented in our cohort (fig 1, top panel). We grouped several jobs and visualised their respective size and mean values in a bubble plot (see table S2 for descriptive summary statistics). At first glance, we observed that workers in research and education had the highest typing speed, closely followed by the medical staff (fig 1, bottom panel). Administrative workers reflected most positively on administration, which is reassuring because this activity encompasses most of their work (fig 1, bottom panel; table S2). The medical and nursing staff, however, reported mostly negative feelings towards administration.
Interdisciplinary differences in typing speed

Next, we compared the various medical departments to one another (fig 2, top panel), excluding respondents who were not affiliated with any particular specialisation (n=784). The highest typing speed was achieved by respondents working in internal medicine, followed by urology then neurology (table 2). The slowest typists worked in medical microbiology, followed by dermatology, and radiology and nuclear medicine. With respect to administrative load, the happiest departments were medical microbiology, pathology, and radiology and nuclear medicine. Obstetricians and gynaecologists, the aggregate group of various other specialisations, and dermatologists were least satisfied (fig 2, bottom panel; table 2).

The effect of age

Age as a factor in the acquisition and execution of fine motor skills is a well described effect:21 25 -29 young people are presumed to have been typing from an earlier age than their more senior colleagues due to the computer revolution. We observed a striking, negative association between typing speed and age (fig 3, top left panel; ANOVA P<0.001), underlined by significant differences between all but the two oldest age groups, as determined by post-hoc Tukey's Honest Significant Difference test (table 2).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Respondent and source population characteristics. Data are number (%), unless otherwise specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years):</td>
<td>Respondents (n=2690)</td>
</tr>
<tr>
<td>&lt;29</td>
<td>1097 (40.8)</td>
</tr>
<tr>
<td>30-39</td>
<td>845 (31.4)</td>
</tr>
<tr>
<td>40-49</td>
<td>404 (15.0)</td>
</tr>
<tr>
<td>50-59</td>
<td>245 (9.1)</td>
</tr>
<tr>
<td>≥60</td>
<td>99 (3.7)</td>
</tr>
<tr>
<td>Gender*</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>620 (23.0)</td>
</tr>
<tr>
<td>Female</td>
<td>2065 (76.8)</td>
</tr>
<tr>
<td>Neither male nor female</td>
<td>5 (0.2)</td>
</tr>
<tr>
<td>Followed a typing course</td>
<td>1283 (47.7)</td>
</tr>
<tr>
<td>Time when typing course was followed (years ago):‡</td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>3 (0.2)</td>
</tr>
<tr>
<td>1-5</td>
<td>11 (0.9)</td>
</tr>
<tr>
<td>6-10</td>
<td>68 (5.3)</td>
</tr>
<tr>
<td>≥10</td>
<td>1201 (93.6)</td>
</tr>
<tr>
<td>Median (IQR), no of fingers used,</td>
<td>9 (6-10)</td>
</tr>
<tr>
<td>Mean (SD) satisfaction with administrative load (0-100)§</td>
<td>46.9 (25.7)</td>
</tr>
</tbody>
</table>

Table 2 | Summary statistics by specialisation by typing speed. Data are mean (standard deviation) unless otherwise specified |
| Specialisation | No of participants (%) | Corrected typing speed (cWPM) | Administrative satisfaction (VAS-WRITE) | Self-reported administrative burden (h/day) |
| Internal medicine | 332 (17.4) | 63.95 (21.31) | 40.78 (26.14) | 3.90 (1.91) |
| Urology | 18 (0.9) | 63.68 (24.52) | 39.33 (25.12) | 4.56 (2.06) |
| Neurology | 115 (6.0) | 63.15 (18.12) | 51.21 (25.16) | 3.37 (2.01) |
| Psychiatry | 106 (5.6) | 62.91 (21.13) | 43.18 (26.76) | 2.87 (1.51) |
| Pathology | 35 (1.8) | 62.48 (20.40) | 61.80 (18.69) | 3.37 (2.04) |
| Gastroenterology | 59 (3.1) | 61.82 (23.10) | 48.08 (27.70) | 4.02 (2.13) |
| Cardiology | 121 (6.3) | 61.67 (22.25) | 45.64 (23.72) | 3.51 (2.10) |
| Pulmonology | 48 (2.5) | 59.84 (19.45) | 52.77 (22.59) | 3.35 (1.98) |
| Anaesthesiology | 76 (4.0) | 59.16 (20.77) | 50.99 (25.99) | 2.83 (1.96) |
| Surgery | 127 (6.7) | 58.91 (19.73) | 38.64 (23.91) | 3.54 (1.86) |
| Obstetrics and gynaecology | 132 (6.9) | 58.71 (21.74) | 35.27 (24.82) | 3.66 (1.77) |
| Paediatrics | 230 (12.1) | 58.45 (22.18) | 39.19 (23.03) | 3.51 (1.88) |
| Emergency medicine | 38 (2.0) | 58.37 (19.30) | 47.74 (25.04) | 2.74 (1.31) |
| Other clinicians | 216 (11.3) | 58.16 (21.01) | 37.78 (23.35) | 3.51 (1.48) |
| Ophthalmology | 38 (2.0) | 57.96 (23.66) | 47.55 (21.78) | 3.18 (1.96) |
| Otorhinolaryngology | 50 (2.6) | 57.00 (19.34) | 54.38 (28.21) | 3.38 (2.03) |
| Radiology and nuclear | 98 (5.1) | 55.22 (19.79) | 56.53 (25.49) | 2.28 (1.64) |
| Dermatology | 19 (1.0) | 51.62 (18.97) | 38.05 (26.77) | 4.42 (2.29) |
| Microbiology | 48 (2.5) | 50.04 (19.96) | 62.00 (20.26) | 3.08 (1.97) |

*χ2<0.001. †The hospital's human resource system does not permit this option. §As a proportion of the respondents who followed a typing course. [i] Some specialties were clustered to enable statistical analyses (eg, internal medicine includes rheumatology, surgery includes plastic surgery and orthopaedics). cWPM=corrected words per minute; VAS-WRITE=Visual Analogue Scale to Weigh Respondents’ Internalised Typing Enjoyment (0-100, where 0 is the most negative and 100 is the most positive).
Differences (oldest two groups not significant from each other, all other comparisons P<0.001). Correlation analysis showed that the number of fingers used to type (r = 0.43, P<0.001) and age group (r = -0.51, P<0.001) were significantly associated to typing speed. Whereas self-reported time spent on administration and the VAS-WRITE score were unrelated to typing speed (supplementary fig S2B). To correct for age in the between-department and between-profession typing speed comparisons, we performed ANCOVA followed by Tukey’s Honest Significant Differences. After correction for age, various observed differences between professions and departments were substantiated. Employees working in research and education and members of the medical staff typed significantly faster than most other professions (fig 3, top right panel), whereas people in internal medicine outperformed microbiology, radiology, paediatrics, and the aggregate group of other clinicians (fig 3, bottom right panel).

**Fig 3** (Top left panel), Boxplot comparing typing speed between the different age groups in the entire cohort (n=2690). Data are represented with a mean line, a box indicating the standard deviation and vertical lines representing the minimal and maximal value. Each dot represents a respondent. Statistical differences were determined by one way ANOVA (P<0.0001) followed by post-hoc correction for multiple testing using Tukey’s Honest Significant Differences (P< 0.0001 in all comparisons, except between the highest age groups, which was P=0.07). (Top right panel) Boxplots comparing typing speeds between the professional groups (n=2690), corrected for age by ANCOVA. The stars represent the significance of the pairwise comparisons as derived from the post-hoc analysis using Tukey’s Honest Significant Differences. (Bottom left panel) Boxplots comparing typing speeds of genders, stratified per age group. Significance was determined by Student’s t test between genders. (Bottom right panel) Boxplots comparing the typing speeds between departments (n=1906), corrected for age by ANCOVA. The stars represent the significance of the pairwise comparisons as derived from the post-hoc analysis using Tukey’s Honest Significant Differences. *P<0.05. **P<0.01. ***P<0.001. ****P<0.0001
Typing speeds between women (n=2065) and men (n=620) were not significantly different (mean difference 0.5 (standard error 0.9) words, 95% confidence interval −1.4 to 2.4), *P*=0.61. Comparison of genders within each age group also showed no major differences, although men appeared slightly faster in age groups older than 30 years (only significant for 30-40 year olds (fig 3, bottom left panel), *t* test *P*=0.04). Overall, female respondents made significantly more typing errors (5.0 (1.8) incorrect characters, (2.3 to 7.7), *P*<0.001), although they ostensibly compensated with more words corrected (0.5 (0.1) words, (−0.1 to 1.0), *P*=0.09) resulting in equal corrected typing speeds. Of note, women were significantly more positive towards administrative tasks (VAS-WRITE score 7.7 (1.2), (5.3 to 10.0), *P*<0.001) than men, which remained significant when comparing physicians only. All together, we observed a strong, negative association between age and typing speed, and significant but more subtle differences between medical specialties and between genders.

### Typing course and typing speeds
To explore the potential benefits of a typing course, we split our cohort between those who had completed a typing course and those who had not. Respondents who had done a typing course in the past used more fingers to type (median 10 (interquartile range 10-10) fingers v 6 (4-8) fingers, Wilcoxon *P*<0.001) and typed more than 20% faster than those that had not (mean difference 12.1 (standard error 0.8) words, 95% confidence interval 10.6 to 13.6), *P*<0.001, even though more than nine (90%) in ten took their course more than 10 years ago. Notably, the age distribution between the two groups was similar (supplementary fig S2B).

### Sensitivity analyses
We performed inverse probability weighting to assess whether age and gender differences between our respondents and the source population influenced our results. Inverse probability of selection weights analysis resulted in a weighted dataset with almost identical age and gender distributions to the source population (table S3). The effect of age on typing speed was substantiated in the weighted analysis (table S4) and differences between age groups remained highly significant (table S5). Similarly, the medical department ranking based on age and gender weighted typing speed was very similar (table S6); however, urology was most affected, possibly due to the small group size. Overall, inverse probability weighting analyses indicated no substantial effect of the age and gender differences between the respondents and the source population.

### Discussion
#### Principal findings
The difference in typing speed between internal medicine and specialties, such as microbiology and dermatology, could reflect the high pressure environment of working on a ward, which might necessitate faster typing, or that only fast typing employees select these fields (or thrive in these fields). Our respondents were almost twice as fast as medical residents in the study by Kalava and colleagues. However, the comparability of both studies is limited because our study was conducted more than six years later, our study population was considerably larger and more varied, and Kalava and colleagues seem to have counted dictionary words rather than sets of five characters, which usually translates to fewer words per minute.

Age was an important factor in the typing speed of our respondents. Is the decrease in typing speed over time a result of declining motor skills? Research from a time in which most typing was done on a typewriter appears to support this theory, but only in part. Salthouse and Bosman reported that skilled older typists exhibited a reduction in fine motor function during various unpractised tasks but were not outdone by their younger peers on short copy typing exercises. Overall, the observed effect is more likely a result of nurture, rather than nature. Younger generations have been interacting with technology from an early age, whereas the older generation, generally, were exposed to working with a computer only later in life. Digitalisation in medicine is a relatively recent phenomenon and people of older age might have yet to fully adapt to this profound change.

Similar to other studies, employees report negative feelings towards administration. When compared with other healthcare professionals, the medical staff regarded their administrative load most negatively, despite managing relatively high typing speeds. Combined with the finding that feelings towards administrative tasks were not correlated to typing speed, this suggests that physicians simply do not like administrative work, irrespective of their typing proficiency. Professionals who engage in relatively little direct patient contact, such as those working in radiology, pathology, and medical microbiology, had the most positive feelings towards administration. Speech-to-text tools, commonly used in these fields, possibly alleviate some of the perceived administrative burden. Previous research has suggested that text prediction, alternative input devices such as specialised keyboards, and improvements to the user friendliness of the electronic health record system, as solutions to the problem of administration. Perhaps most importantly, many administrative tasks are thought of as superfluous and can be withdrawn without any impact on the quality of care. In summary, our findings provide further support that medical professionals perceive their administrative burden negatively, and underscore the need to resolve this issue in modern medicine.

### Limitations of this study
Respondents completed the test in an uncontrolled setting. Although this environment has the potential for disturbances (eg, patients calling for assistance),
our design does accurately reflect the real-world situation in which our respondents do most of their typing. General Data Protection Regulation (known as GDPR) compliance meant that we were only permitted to collect certain data at a more aggregated level, such as age measured in decades, which reduced the correction power of these parameters. Additionally, copying a text about Santa Claus is clearly different than typing from memory, and does not take into account the use of shorthand, shortcuts, or short notes. Work related to electronic health records also involves tasks such as navigating tabs and ticking boxes, which require an overall affinity with computers that is not captured by only measuring typing speed. We note that our electronic health record system, EPIC (Epic Systems Corporation, Verona, WI, USA), is reportedly used for the healthcare of 250 million patients across the world, which improves the generalisability of our cohort. The VAS-WRITE score is subjective and represents feelings towards administrative tasks in general, and not the electronic health record system or typing specifically. Finally, the baseline differences between our respondents and the source population can indicate a degree of response bias. However, an inverse probability of selection weights sensitivity analysis showed that the age and gender differences did not change our results. As our human resource systems do not link employees to specific departments, we were not able to assess or account for departments that might be over-represented or under-represented in this study compared with the source population, which is a limitation.

Conclusion
In summary, these findings provide evidence about the typing proficiency of the healthcare community. We found important interdisciplinary differences and note that older healthcare professionals are at an overall disadvantage in an increasingly digitalised medical world. These results can help to progress future research on the effect of typing and data entry on the day-to-day work of healthcare professionals. This future research should yield more in-depth data for ways to improve these processes and thus potentially improve job satisfaction as well. Combined, these data could inform the implementation of training modules to increase typing speed, and instigate alternative methods of data entry to resolve this imbalance.

We thank all colleagues who participated in this study for their contribution to this important piece of research. We also thank Rutger de Gaaf, for building and maintaining the web based application; Ingrid Blom and her colleagues, for querying the human resource systems; Saskia van de Ven, for helping us out with sending an email, right when we needed her the most; Loes Magnin and her colleague Sophie Ruiter-Verschoor, for consulting on the text of said email and other communication aspects of this project; Simone van der Heijden and Hans van den Heuvel, for their advice on making our project General Data Protection Regulation (GDPR) proof; José Sanders, for being a sounding board on the linguistic aspects of the study; and the Board of Directors of Amsterdam UMC, for their continued support for this research project.

Contributors: ARS and MEB contributed equally and share first authorship. They conceived the idea of the study and were primarily responsible for its design and execution, and the analysis of the data. They co-wrote the first draft of the manuscript. WJW and JWH supervised the project and reviewed and approved the final draft of the manuscript. ARS is the guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/disclosure-of-interest and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: This study was conducted in conformity with the Declaration of Helsinki and institutional guidelines and procedures. This study was not subject to the Dutch Medical Research Involving Human Subjects Act and therefore did not require approval from the medical ethics committee of Amsterdam UMC. Respondents were not paid or rewarded in any way for their participation. Data were anonymised at all stages of the study to make the study compliant with the General Data Protection Regulation.

Data sharing: ARS and MEB had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Data are available on reasonable request from the corresponding author.

The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination to participants and related patient and public communities: Results will be communicated to respondents and all other hospital staff through the hospital’s internal bulletin board.

Provenance and peer review: Not commissioned; externally peer reviewed.

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