# *An analysis of computer use across 95 organisations in Europe, North America and Australasia*

## *Wellnomics® White Paper*

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## Introduction

Duration of computer use has been shown to be an important risk factor for the development of hand-arm and neck-shoulder symptoms[1, 2, 3, 4, 5, 6]. Traditionally user self-reports have been used to measure duration. However, recent studies comparing self-reports against direct observation of activity (by an observer, or video analysis) have called into question the accuracy of these self-reports[7, 8], finding that averages calculated from self-reports overestimated actual usage by 40-100%. As well as over-estimating, the correlation between self-reports and actual usage is not high, as figure 1 below from the study by Douwes et al, 2004[7] illustrates.

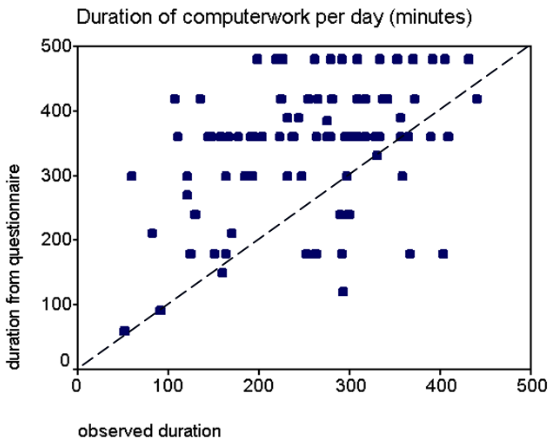


*Figure 1. Correlation of self-reported duration against that measured by observation.*

Why user self-reports overestimate computer use by such a large degree is unknown. It may be that user's tend to remember the peak's in their workload when estimating their usage, or that they don't take into account the many other activities they do during a work day, such as time on the phone, or in meetings.

This is worth investigating further, but whatever the reason, it does call into question the reliability of previous study results based upon self-assessment of duration. It could also impact any recommendations on safe exposure levels which have been based upon these results to date.

Note that duration of computer use in this context is defined as more than just the active time spent typing, or moving the mouse. Keeping in mind that static muscle loading is believed to be an important mechanisms in the development of musculoskeletal symptoms, we are interested in total time spent at the computer, including time pausing between activity, and time reading from the screen.

If we do not rely upon self-reports, the alternative of direct observation is, unfortunately, impractical for large studies. However, in recent years 'odometer' software installed on the user's computer has been shown to also provide accurate and reliable measurement of computer use. This software runs continuously in the background on the computer monitoring all keyboard and mouse activity. If regular activity is being detected, we can assume that the user is still at the computer. If no activity is detected for a longer period, we can assume that the user is no longer using the computer.

This approach requires the setting of a threshold at which the user is defined to be, or no longer to be, using the computer. Obviously at any one point in time this will be a guess – as we do not have any way of visually confirming what the user is doing. For example, the user may happen to spend a long time viewing a presentation on screen without using the keyboard or mouse. However, if the threshold is chosen appropriately, then, as per sampling theory, the total usage recorded over time can be relatively accurate.

Several studies have specifically looked at the Wellnomics WorkPace software and its accuracy[7, 9, 10]. Figure 2 shows a set of results from the Douwes et al, 2004[7] study comparing odometer measurements of duration with those from direct observation.



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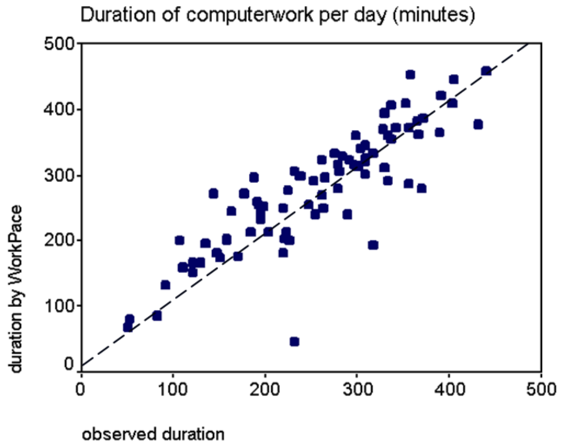



*Figure 2. Correlation of duration measured by Wellnomics WorkPace against duration measured by observation.*

Contrasting figures 1 and 2 it can be seen that the software provides significantly greater accuracy compared with self-reports, with the average duration measured by Wellnomics WorkPace found to be within 10% of that measured by observation. A second study performed by Blangsted et al, 2004[10] found similar results, concluding that:

> *'The [Wellnomics WorkPace] software may be used as a valid tool to measure exposure in large epidemiological studies or to provide objective feedback on time spent at the computer and usage of keyboard and mouse…'*

Use of 'odometer' software also provides many other advantages over other duration assessment methods. For example, it allows:

- Collection of detailed statistics on every aspect of computer use, including mouse and keyboard use, number of keystrokes and mouse clicks, number of breaks taken, and which applications are being used.
- Ability to monitor large numbers of users over long periods – up to thousands of computer users over periods of up to several years.
- Day-by-day monitoring, allowing both short term and long term trends and variability to be analysed.
- Low overheads in collating data – recorded data is easily collected and imported into statistical analysis tools.

Consequently, there appears to now be a simple and reliable method available for collecting accurate exposure data for long periods and across large user populations. A number of recent studies such as the Danish NUDATA[1] and Dutch PROMO[11] studies have taken advantage of this method, using the Wellnomics WorkPace software to collect continuous exposure data on population sizes of 2,000-6,000 users over periods of 1-2 years.

However, there is as yet little data covering large populations of computer users. It would be useful to have reliable baseline data on what computer use levels are amongst the average working population. This paper attempts to provide some answers to this question.

The Wellnomics WorkPace software tool which Wellnomics Ltd manufactures provides two key features to clients (i) breaks and exercise prompts for the user, plus ergonomics training on musculoskeletal disorders/discomfort (MSD) prevention, and (ii) 'odometer' style recording of statistics on computer use.

Several thousand organisations are using this software worldwide, with over one million licenses sold. Wellnomics also provides analysis and reporting services to organisations whereby clients can send their data to Wellnomics, or its representatives, to analyse on their behalf. Reports are then provided to the client analysing the levels and patterns of computer use in their organisation. Over the last 5 years

Wellnomics Ltd has obtained permission from a number of these clients to retain an anonymised cross-sectional sample of the data analysed. As a result, over the last 5 years Wellnomics has built up a database of data from nearly 100 organisations using the WorkPace software. To our knowledge this is possibly the largest sample of odometer measured computer use data collected to date.

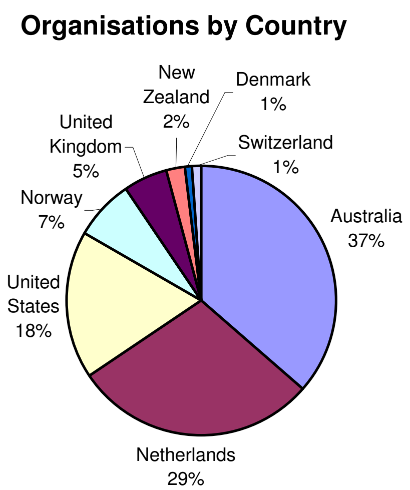
This paper presents the results of an analysis of this data, with the goal of finding out the baseline levels of computer use duration in the working population and gaining an understanding of the variability in exposure between users, organisations and countries.

## *Methods*

Over the last 5 years data has been collated from just under 100 organisations and nearly 50,000 computer users. The amount of data available from each organisation varies considerably (from 20 employees to over 10,000) and so a cross-sectional sample of 20 random users from each organisation has been taken, resulting in a dataset of 1,800 users.

The distribution of these organisations by country and by industry sector is shown in Figure 3.

It is accepted that this distribution of organisations and industries is not necessarily a representative of the wider population, it simply represents a cross-section of the client base using Wellnomics products. It, however, does not appear to show an overwhelming bias to any one industry sector (see Figure 3). However, only a minority of organisations choose to implement stretch-break/monitoring software, and these organisations may not be representative of the wider population. For example, it is possible that the organisations implementing this software have higher incidences of MSDs and higher levels of computer use on average. Additionally, as most of these organisations have breaks and exercise prompts, and daily limit warnings enabled, it is also possible that computer use levels in these organisations have changed as a result of implementing the software.



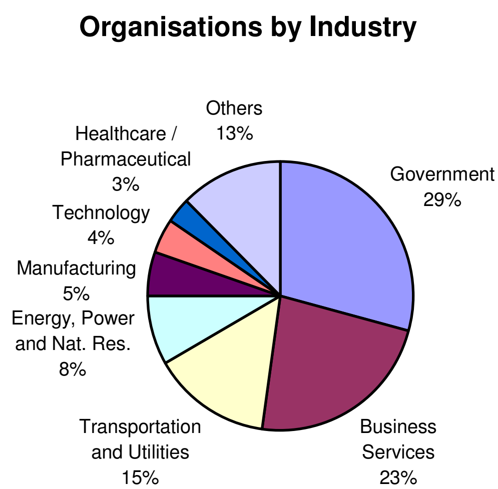




*Figure 3. Distribution of organisations in analysis by country and industry sector.*

The data was analysed using the *Wellnomics WorkPace Reports* software tool that accompanies WorkPace. The first 4 weeks data was selected for each user with start dates randomly distributed. Users that did not have data available for more than 75% of this time period were excluded. This is to exclude users who have less than three weeks of data recorded, either due to work absence, or due to the recording period actually being shorter than the 4 weeks required. This resulted in the exclusion of 9% of users, with a final dataset of 1,638 users across which the analysis was completed.

To determine if a 20 user sample was sufficient, for 8 of the organisations for which much larger source datasets were available (up to 10,000 users) averages were calculated across the full source dataset. In several of these cases the source dataset actually covered all employees in the organisations concerned, ensuring the true organizational averages could be calculated. Averages were then calculated for several randomly selected 20 user sample sets from each organisation and compared with the averages calculated across the full source datasets. The average error was found to be 11%. The error for the combined average of all the samples (i.e. 160 users) was found to be smaller, at less than 5%. This is to be expected, of course, with errors for individual averaging out in these larger samples.

This suggests that the results of any country or industry sector level analyses are likely to be representative of the true mean of the organisations contained to within 5-10%.

This said, for the majority of cases our source dataset only contained a subset of all the employees in the organisation. Accordingly, although our 20 user sample may be representative of the source dataset, it is unknown how representative the source dataset is of the wider organisation. For example, some of the datasets were from just one or two specific departments in these organisations. These departments may have higher or lower levels of computer use than the rest of the organisation.

## *Results and Discussion*

### Average Computer Use

Taken over the entire population average computer use was found to be 12.4 hours per week (2.48 hours per day over a 5 day working week).

In terms of weekly duration, only 12% of users had average computer use exceeding 20 hours a week, with 0.6% exceeding 30 hours a week.

In terms of daily use, 24% of users exceeded 6 hours in a day at least once during the 4 week period, with nearly half (48%) exceeding 5 hours. The average peak computer use during the 4 week period was 4.9 hours in a day.

Average keystrokes were 23,800 a week or about 1,900 per hour of usage, with mouse-clicks being about one third of this (Table 1).

| Statistic | Average Weekly | Peak Daily |
|---|---|---|
| Computer Use | 12.4 hours | 4.9 hours |
| Mouse Use | 6.9 hours | 2.8 hours |
| Keystrokes | 23,800 | 11,600 |
| Mouse Clicks | 7,400 | 3,400 |

*Table 1. Average computer use across all organisations (4 week period)*

### Distribution of Computer Use

Figures 4 and 5 below shows the distribution of computer use and mouse use. There appears to be a wide variation in use. It is interesting to note that peak use for some users reached up to 12 hours in a single day. Mouse use showed a similar distribution to computer use, but with a lower average.

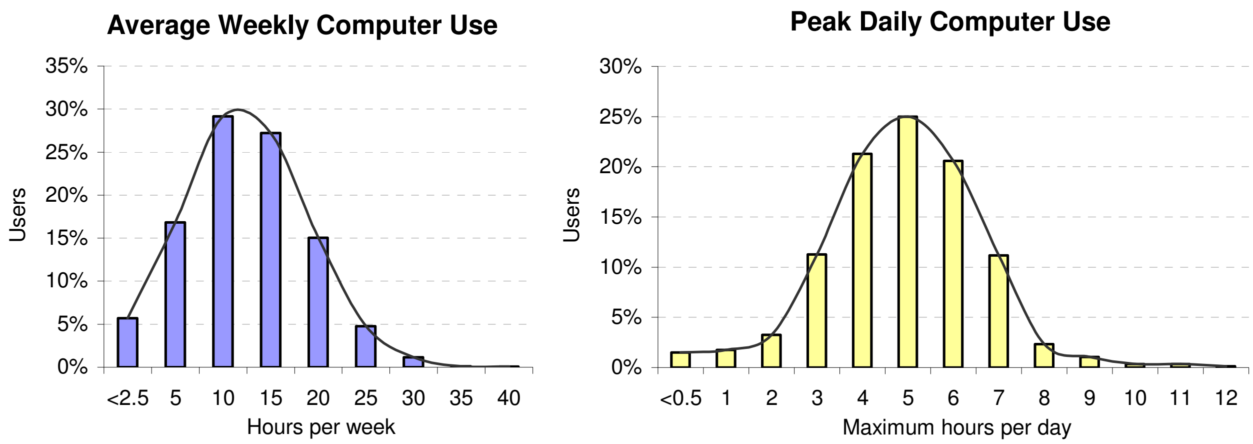
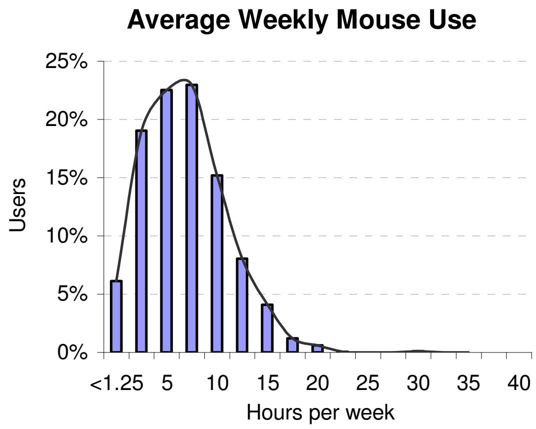



*Figure 4. Distributions of average weekly, and peak daily computer use (over 4 week period)*



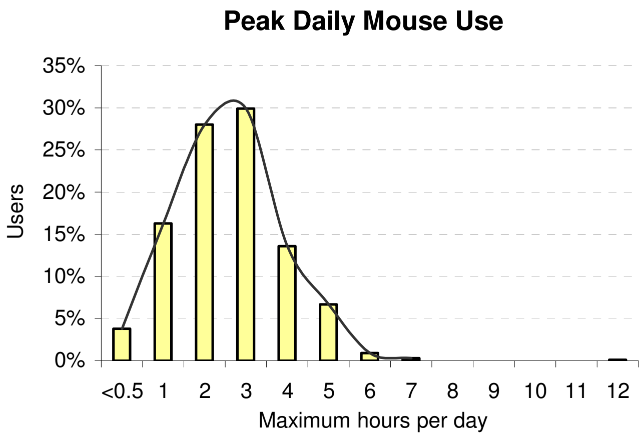




*Figure 5. Distributions of average weekly, and peak daily mouse use (over 4 week period)*

## Comparing Different Countries

What differences in computer use duration were found between countries? To answer this question only those countries for which data on 5 or more organisations was available were compared. These results should be interpreted carefully, as it is unknown how representative these samples are of the wider population in each country. There could be bias towards particular industry sectors or groups of higher or lower computer users in some of the smaller samples.

Analysing this data showed surprisingly significant differences between countries. The highest computer use was found in the UK sample, with 16.8 hours a week, while the Netherlands was the lowest, with almost half the duration of the UK, at 9.3 hours a week. A similar pattern was found for mouse use (see Table 2 and Figure 6).

Results for “work rate” or the speed of keyboard and mouse activity (keystrokes & mouse-click rates) were a little different, with the Netherlands increasing its position to third (Figure 7).

| Country | Sample Size, Organisations (users) | Computer Use hours / week | Mouse Use hours / week | Keystrokes per hour | Mouse clicks per hour |
|---|---|---|---|---|---|
| UK | 5 (100) | 16.8 | 9.1 | 2,650 | 1,060 |
| USA | 17 (340) | 14.5 | 8.7 | 1,730 | 1,080 |
| Australia | 35 (700) | 13.6 | 7.6 | 2,000 | 1,120 |
| Norway | 7 (140) | 10.0 | 5.8 | 1,580 | 920 |
| Netherlands | 27 (540) | 9.3 | 4.7 | 1,900 | 1,030 |

*Table 2. Comparison of computer use across countries.*

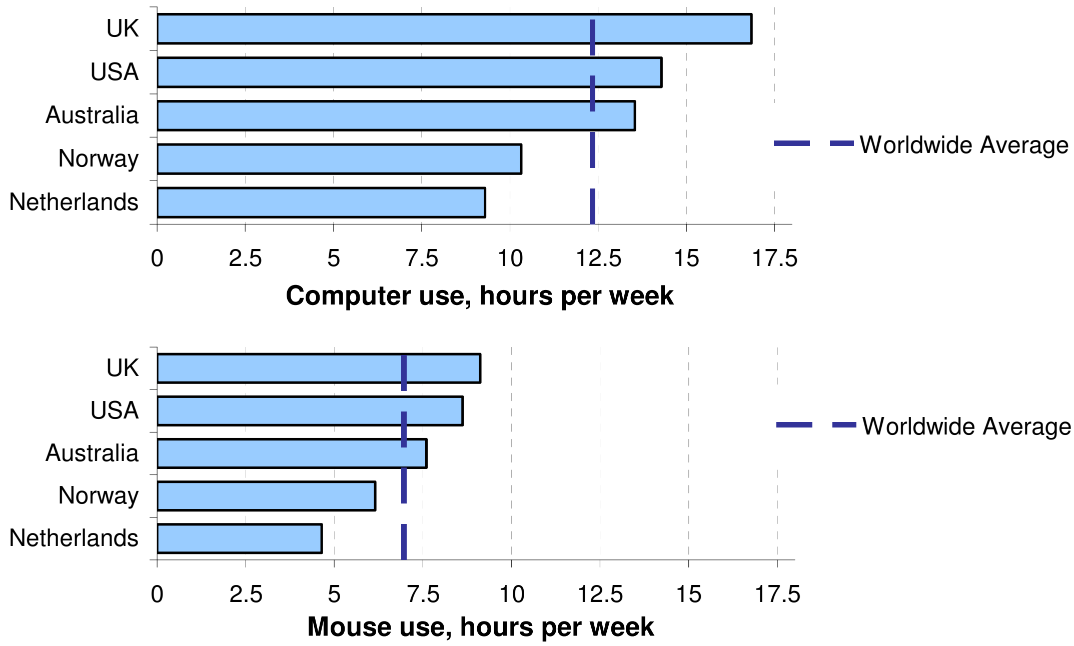



*Figure 6. Comparison of computer use and mouse use by country.*

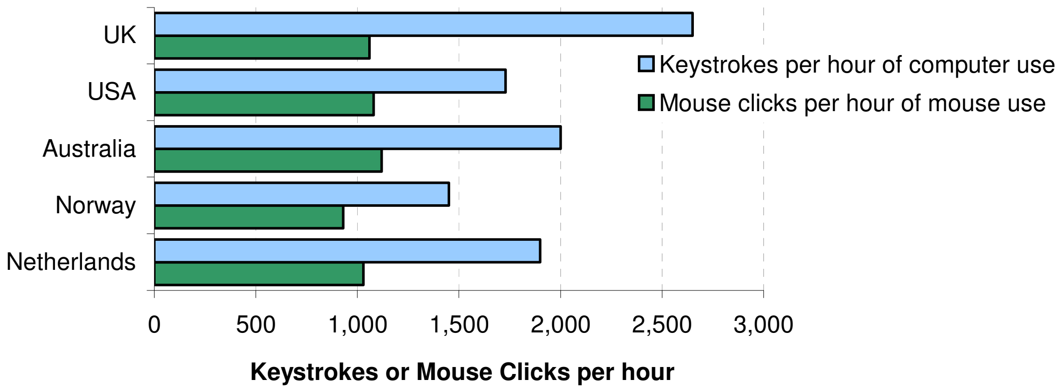



*Figure 7. Comparison of keystroke and mouse-click rates or "work rate" by country.*

To get a better understanding of the variation in usage within each country averages were calculated for each organisation. Figure 8 shows the results, with there actually being a great deal of variation between organisations ranging from averages of just 3.3 hours a week, up to almost 20 hours a week. Once again, caution should be exercised in interpreting the averages presented for the smaller sample sets such as those for the UK and Norway.

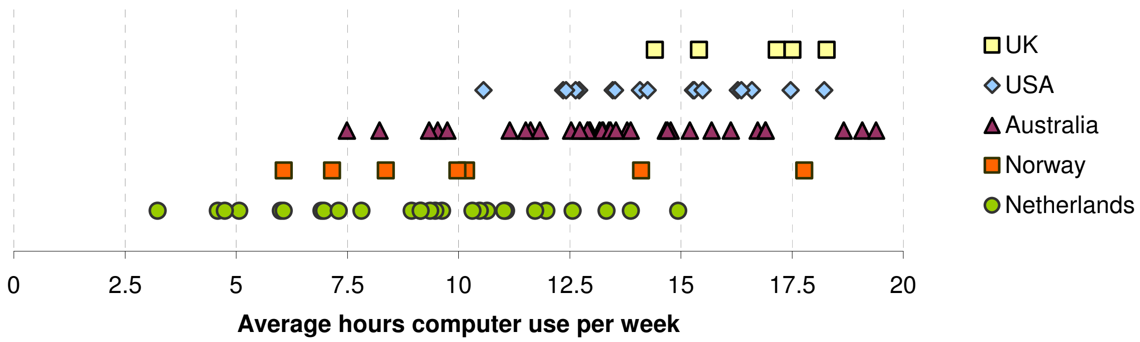
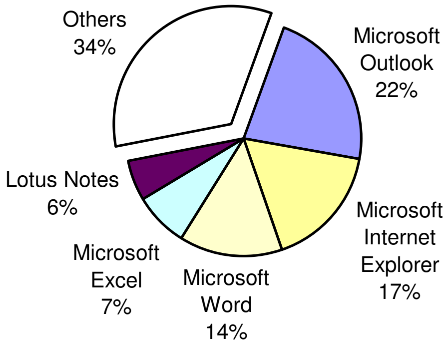



*Figure 8. Distribution of organisational averages by country.*

## Application Use

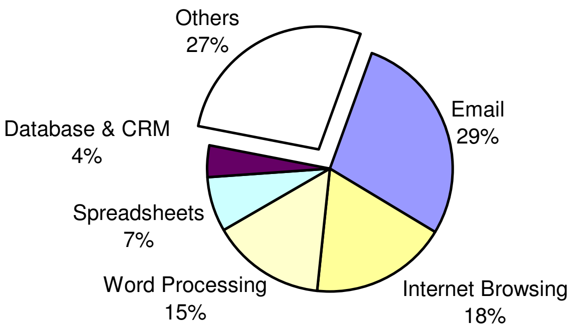
The Wellnomics WorkPace software is able to record specific information on application usage, including the time spent using each application and number of keystrokes and mouse clicks performed in each application.




| Applications | % Total Computer Use |
|---|---|
| Microsoft Outlook | 22% |
| Microsoft Internet Explorer | 17% |
| Microsoft Word | 14% |
| Microsoft Excel | 7.4% |
| Lotus Notes | 5.6% |
| **Total** | **66%** |

*Figure 9. Top 5 applications used on computer, by time at the computer.*

Analysing this showed that, averaged across all organisations, Microsoft Office accounted for over 60% of all the time spent using the computer, with Microsoft Outlook occupying the number one spot on 22% (Figure 9).




| Tasks | % Total Computer Use |
|---|---|
| Email | 28% |
| Internet Browsing | 18% |
| Word Processing | 15% |
| Spreadsheets | 7.4% |
| Database & CRM | 4.2% |
| **Total** | **73%** |

*Figure 10. Top 5 tasks for which computer was used, by time at the computer.*

Perhaps more interesting than the exact application being used is what the most common tasks are that users perform with the computer. There are a range of different applications that can be used for the same task. For example, Outlook and Lotus Notes are both primarily Email tools, and Internet Explorer, Netscape and Firefox are all Internet browsers. Accordingly, grouping applications by the most common task they are used for provides us with an estimate of the time the average computer user spends on each task (Figure 10). Email comes out the clear winner with 28%. The top 5 tasks together account for 73% of all computer use.

## *Discussion*

At just 12.4 hours a week, average duration of computer use appears much lower than commonly expected. Perhaps this is not surprising considering most previous measurements of duration would have relied upon self-reports, which have been shown to overestimate exposure significantly. This may have implications for existing guidelines on safe duration levels and any new guidelines being considered for safe working limits on computer use. For example, in the Netherlands article 5.10 of the official VDU regulations (the *Arbeidsomstandighedenbesluit*) specifies a limit of 6 hours computer use in any one day. Additionally, the banking industry in the Netherlands have agreed with their unions a more stringent guideline of 5 hours maximum computer use. If these guidelines were originally based upon self-report studies they may need to be updated to reflect the more accurate methods now available and the fact that these self-reports overestimate duration. As a consequence, it may be that actual 'safe' duration levels are lower than previously thought.

A complicating factor today in measuring total exposure of office worker is the increasing home and personal use of computers. This analysis only looked at computer use in the workplace. How much extra computer use is added each week from non-work use is unknown, but possibly substantial for a proportion of users.

As well as the duration of computer use being relatively low, the level of 'repetitive' activity performed by the average computer user is also quite low. A professional typist typically performs 10-15,000 keystrokes an hour. By comparison, the average computer user in this analysis did just 1,900 keystrokes and 600 mouse clicks an hour. This does not support the theory that MSDs or RSI are primarily related to 'repetitive' keying activities. Average computer use today does not appear to involve high levels of repetition.

The average working week across the countries studied is normally 37.5-40 hours. However, very few users got close to achieving 35 hours a week or more of computer use (only 0.2%). This suggests that even full time computer users spend long periods away from their computer. The composition of the working day for the average office worker is likely varied, but despite the increasing computerisation of the workplace there is obviously a lot of non-computer work still required in the average work day. It may be that due to the nature of a modern collaborative office working environment it is difficult to reach close to 40 hours actual computer use in a 40 hour working week. To investigate this further a more detailed preliminary analysis was done of some of the highest users. Looking at activity start and end times (which are also recorded), and how many days for which activity was recorded suggests that to reach 35+ hours a user must regularly working longer than a 40 hour week. For example, starting at 8:30am and working until 10pm or midnight, or working weekends as well as work days. The highest users had peak use of 10-12 hours in a day.

Comparing usage by country shows some surprisingly large differences between different countries. Looking at the large variability from one organisation to the next (Figure 8) it may be that the sample sizes for Norway, and the UK in particular, were too low, possibly providing unrepresentative results. No statistical tests have been applied yet to the dataset to gauge the significance of the differences between countries. However, with the large differences found and the reasonably wide selection of organisations for Australia, USA and Netherlands, it does appear likely that significant differences do exist between countries. Why there should be significant differences is unknown. It's possible that lower averages for Netherlands and Norway may be due to a higher incidence of part-time workers in these countries. It could be that in excluding part-time workers from the analysis (if information on the work status of users was available) the differences in usage between the countries would be less.

Looking at the applications used it is easy to see why Microsoft is a highly successful company – Microsoft's products appeared to account for the majority of time spent using the computer, with Outlook, Internet Explorer, Word and Excel being the top 4 applications. In terms of tasks, email takes the largest slice of time, accounting for 28% of all time on the computer. With 12.4 hours average weekly computer use, this means nearly 45 mins a day is spent on average using Email software. Second with 18% is Internet browsing. Does this mean a fifth of office workers computer use is being spent 'browsing the internet'? More likely it may reflect the increasing use of corporate intranets and web-enabled corporate applications that are accessed via a browser interface.

Overall, the top 5 applications and top 5 tasks accounted for the majority of computer use (66% and 73% respectively). This suggests a surprising degree of homogeneity across organisations and industry sectors in terms of the key activities for which the computer is used. Further analysis of organisational and industry sector differences in application use to see what differences are actually present would be interesting.

## *Implications and Future Opportunities*

These results illustrate the tremendous variety of data that can be obtained using odometer software. The ease of collecting and analysing the data, the reliability and accuracy of the measurements and the feasibility of monitoring large populations for long periods suggests such odometer software may become an increasingly useful tool in epidemiological and interventional research in office ergonomics. The use of odometer type software has far reaching potentials.

The fact that most research on exposure to date has been based on self-reports suggests that further research is now needed using the more accurate assessment methods now available. Until such research is available any conclusions on the relationship between exposure and MSDs, and recommendations on safe exposure levels may be premature. It is suggested that future studies in the office ergonomics field may consider adding odometer derived exposure measurements to the variables collected from study participants.

One potential issue with odometer software is the technical challenges of getting such software installed on the computers in an organisation. Although the installation itself is straightforward, gaining the permission and co-operation of company IT departments can be more problematic. Software that is installed on every computer and that continuously records all the mouse and keyboard activity can be viewed as a stability and security risk. In reality, the Wellnomics WorkPace odometer software in particular does not record specific keystrokes (from which passwords or actual words typed could be reconstructed) and is proven to be highly stable, running successfully on over a million desktops worldwide for many years. However, most IT departments will have strict policies regarding the installation of new software on their computers, and require full compatibility testing of any software before it is installed. For this reason, it may instead be easier to deliberately target, for intervention studies, those organisations that already have odometer software such as WorkPace installed. The challenge is then reduced to gaining permission for access to existing information that is being recorded.

Other potential applications of odometer software include the possibility of providing automatic identification of users at high risk of developing MSDs. If the data recorded by the odometer is automatically communicated to a central database in the organisation, then continuously updated information on exposure levels across the organisation can be placed at the fingertips of Occupational Health & Safety personnel. This would allow immediate identification of high risk users as well as tracking of trends in exposure over time. It would also be possible to provide users with objective feedback on their own exposure and thereby encourage them to self-moderate their activity so as to minimise their risks.

As well as exposure assessment, odometer software may lend itself to use as a measurement tool in other areas of ergonomics and human factors. For example, in software and process design odometer software could be used to monitor changes in the length of time to complete tasks or the number of mouse clicks or keystrokes required. Improvements to software could be made to minimise mouse and keyboard actions required.

Changes in behaviour patterns due to the use of different equipment could also be monitored. For example, odometer software can record use of numeric keypads, function and shortcut keys, and use of scroll wheels and different mouse buttons. The effects of different types of equipment such as split keyboards, separate numeric keypads, or different mouse designs on user activity patterns can then be directly measured.

Application data recording opens up even wider research area potential. The effects of training on both tasks (e.g. word processing skills, use of shortcut keys, improved ways of managing e-mail) and on how specific applications are used can be directly recorded. If training improves the efficiency of workers at completing their tasks, this improvement should be evident in the data recorded, showing up as less time spent on the task or application, or less keystrokes and mouse clicks to complete the tasks.

In summary, using odometer software can allow the collection of a large variety of robust data from large populations. The data collected by this means has many possible applications for research and interventions in office ergonomics. Odometer software is a tool which is likely to be very useful for a wide range of researchers and ergonomics practitioners.

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## About Wellnomics Ltd

Wellnomics Ltd is a manufacturer and supplier of ergonomics software based in New Zealand. Their key products include the Wellnomics WorkPace and Wellnomics Risk Management software products.

Wellnomics WorkPace is stretch-break software (see www.workpace.com) designed to help prevent and rehabilitate MSDs. WorkPace is used by many thousands of companies worldwide, with over 1.2 million licences sold to date, and is the market leader in its category.

The Wellnomics Risk Management software (see www.wellnomics.com) is a tool that integrates with WorkPace to provide risk assessment, risk reporting and ergonomics training tools for office workers. The software is used by health and safety departments to evaluate risks in their organisations, identify high risk users, and target interventions. The software uses a new risk model developed by the TNO Research Institute that evaluates overall MSD risks by combining odometer measured exposure data with user questionnaires on workstation layout, symptoms history, individual and psychosocial factors, and then providing appropriate expert recommendations.

Wellnomics has a strong focus on research in the office ergonomics field, including active membership of the US based research funding organisation the Office Ergonomics Research Committee (OERC), a research partnership with the Netherlands TNO Work and Employment Institute and the provision of software research tools to many researchers in the office ergonomics field across Europe, North America, and Australasia.

In line with Wellnomics commitment to supporting research a special research version of the WorkPace Recorder/Wellnomics Recorder odometer software is available and provided free of charge to researchers. To date Wellnomics WorkPace has been used in more than a dozen studies on computer use.

Wellnomics Ltd benefits from this involvement in research by being able to bring their clients the latest insights into office ergonomics and MSD prevention.

Researchers interested in conducting research using the Wellnomics odometer software can contact Wellnomics Ltd at research@wellnomics.com.