The Wear-It Study

Using Wearable Technologies to Characterise Physical Interactions in Workplaces

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Background - The PROTECT COVID-19 National Core Study [1] was a UK Government-funded research programme that addressed important questions related to the transmission of the SARS-CoV-2 virus (causing COVID-19 disease) in the environment, including in workplaces, transport and other public settings.
The transmission of infectious respiratory diseases such as COVID-19 occurs via inhalation of airborne viruses generated by infected individuals, but also by touching contaminated surfaces and by person-to-person interactions. The aerosols we generate can stay airborne far and long enough for others to inhale.
Staying at home, physical distancing (2 m distance rule in the UK) and limiting occupancy were different social distancing restrictions recommended by Public Health Departments worldwide to reduce the incidence of respiratory disease transmission amongst the population. Isolation of infected individuals and their "close contacts" (which the NHS in the UK defined as individuals being within 2 m of each other for more than 15 minutes or 1 m from each other for 1 minute or longer) was also enforced at the height of the pandemic. These control measures were implemented in the workplace too.

Understanding gaps – How well control measures, particularly workplace social distancing, may be able to mitigate the risks of transmission and spread of the coronavirus in workplaces is not well understood. High quality data on contacts between workers in and out of workplaces under different controls are still lacking. Such data will assist the construction of contact pattern networks that can feed into disease transmission models.

The Wear-It Study [2] - Aimed to characterise interactions between individuals in workplaces in terms of frequency, distance and duration. Wearables were distributed to collect individual-level paired interactions extending up to 5 m from consenting participants from UK workplaces. Ethics was approved by the University of Sheffield.

Technology - Participants wore an ultra-wideband/Bluetooth low energy device (**Fig. 1.a**) while at work which collected information on other devices worn by colleagues in proximity. Data on interactions between participants were enriched with location information provided by beacons (**Fig. 1.b**) deployed in these workplaces and complemented by information collected using questionnaires. Following the first deployment, the technology was shipped to each site and distributed to participants by a workplace representative (H&S Manager) without any researchers being present.

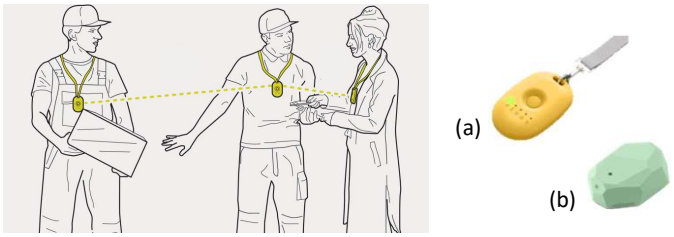


Fig. 1: *(a) proximity wearable device worn with lanyard - can also be worn in a front pocket without lanyard; (b) static beacon (adapted from https://estimote.com/)*

Contact data collected - stored on wearables and uploaded to the cloud at regular intervals (using a multi-provider SIM card). It includes:

- individual-level paired interactions (wearable-wearable interactions collected up to 5m at 10 cm intervals every 1 second)
- occupancy information (wearable-beacon interactions, duration of interaction for when wearable within 10m range of beacon)
- motion information (hourly kinetic index).

Volunteering workplaces - The methodology was piloted from January to April 2022 at (1) a large laboratory, (2) a food manufacturing site and (3) a group of engineering companies. Deployments lasted for up to two weeks at each site.
Additional sites were recruited post April 2022 but these data are not presented here.

Tab. 1: *participating workplace characteristics*

	Workplace 1	Workplace 2	Workplace 3
Workforce size	385	185	156
Participant numbers	106	47 (including 2 visitors)	70
Average daily participation rate	45.6%	12.7%	25.0%

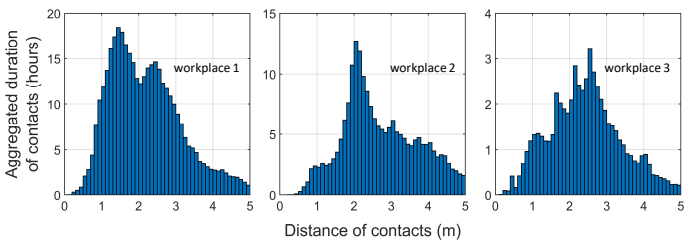


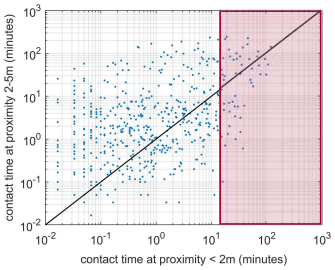
Fig. 2: *Aggregated contact time over all participant-days at each volunteering workplace*

Most contact time (**Fig. 2**) occurred beyond 0.5 m and duration of contact increased with distance up to about 2.5 m. The decrease beyond 3 m was likely linked to the wearable's settings not being optimised for that range (corrected in later deployments).

Tab. 2: *number and duration of contacts per participant-day collected at each workplace*

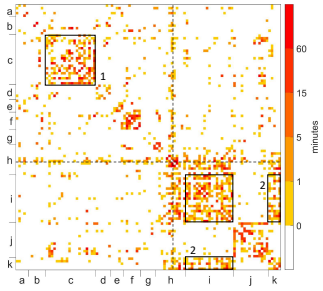
Workplaces	Median durations (mins)			Median numbers			
	Close range	Short range	Medium range	Close contacts	Short range >1 min	Medium range >15 min	Questionnaire*
1	0.7	18.3	20.2	1	2	2	3-5
2	0.9	15.0	37.2	1	2	3	3-5
3	0.1	1.8	4.0	0	1	1	1-2

Close range defined as under 1m; Short range defined as under 2m; Medium range defined as 2 to 5m;
*self-reported number of close contacts with colleagues at work



The red shaded area in **Fig. 3** highlights the time threshold used by NHS test & trace. Only 6% of contact events < 2 m lasted longer than 15 minutes yet accounted for more than 66% of the total contact time < 2 m.

Fig. 3: *correlation between short and medium range contact durations in workplace 2*



In **Fig. 4**, each pixel represents an individual-level paired interaction under 2 m, while the colour refers to the duration of the interaction. "a" to "k" refer to different participant groups (identified by their main work locations):

- *"1"* shows contacts taking place *within* group *c*;
- *"2"* shows contacts taking place *between* groups *k* and *I*;
- dashed lines show potential "superspreader" with high level of contacts through the whole organisation

Fig. 4: *contact matrix – interaction durations at short range for all participants in workplace 1 (summed over the duration of the full deployment)*

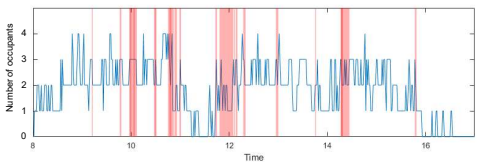


Fig. 5 shows the occupancy of an office in workplace 1 (blue trace) and the periods of contacts between participants (< 5 m for > 1 minute, red). Despite multiple occupancy, for most of the day, participants are not interacting in this office.

Fig. 5: *office occupancy reported at 1 minute intervals*

Study Strength

- highly detailed data on interactions between workers extending up to 5m collected
- data collected in workplaces remotely using wearable technology (no specialists on site)
- workplaces and workers willing to participate in the study (wearables + questionnaires)

Study Weakness

- not all individual contacts are accounted for (participation rate not 100%)
- data collected after most restrictions were lifted (no comparison possible between different restriction regimes)
- wearable settings were not optimised for contacts between 3 to 5 m for these study sites

Conclusion - Remote deployment of wearables in the workplace for the collection of detailed contact data is achievable during a pandemic. Workplaces and workers are willing to join such a study and helped to collect contact data exploitable by transmission risk models. The data collected provided new insights into patterns of workplace contacts that are relevant to understanding transmission. The de-identified data collected from this study will be made available to the wider research community.

Acknowledgement
The authors would like to thank each workplace and their willing participants for their help and for their efforts in generating contact data and completing questionnaires. We would like to thank Estimote (Krakow, Poland) for their technical support.
This poster and the work it describes were funded by the PROTECT COVID-19 National Core Study on transmission and environment, which was managed by the Health and Safety Executive (HSE) on behalf of the HM Government (United Kingdom). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

References

1. PROTECT COVID-19 National Core Study (see: https://bit.ly/3x3OvwE)
2. The Wear-It study (see https://bit.ly/3qXpdPI)