

earliest accelerometer-based mortality studies pooled in this report. However, there is a need for stronger evidence regarding the primary method used here, since several other viable methods have been shown to produce higher values.^{6,7} By contrast, empirical support exists for the accuracy of the method used to estimate sedentary time and, consequently, total activity, in comparison with strong reference measures.^{8,9} High-quality performance-evaluation studies are needed to strengthen our accelerometer-based measurement methods for public health applications.^{10–12} That said, the methodological differences noted here probably affect only the magnitude of the impact for moderate-to-vigorous intensity physical activity but do not alter the more comprehensive findings and importance of this report.

Ekelund and colleagues⁴ have quantified the public health impact of physical activity by showing that a substantial number of deaths could be prevented each year with modest reductions in sedentary time and increases in physical activity across the population. Accelerometer-based studies of physical activity and mortality have broadened our understanding of the range of daily activities that might affect health, and we now have strong evidence that targeting either the least active segment of the population or the population as a whole has a significant impact at the population level. This report provides important public health data to inform clinicians, public health workers, and policy makers in their efforts to boost physical activity and improve population health.

This Comment was supported in part by the Intramural Research Program of the National Institutes of Health (NIH). The contributions of the NIH author are

considered Works of the US Government. The findings and conclusions presented in this Comment are those of the author and do not necessarily reflect the views of the NIH or the US Department of Health and Human Services. We declare no competing interests. We used Grammarly to check spelling and grammar and after using this tool we reviewed and edited the content as needed and take full responsibility for the content of the publication; no confidential data from the Article were input into Grammarly.

*Charles E Matthews, Pedro F Saint-Maurice
charles.matthews2@nih.gov

National Institutes of Health, National Cancer Institute, Division of Cancer Epidemiology and Genetics, Rockville, MD 20892, USA (CEM); Champalimaud Foundation, Breast Cancer Research Program, Lisbon, Portugal (PFS-M)

- 1 WHO. WHO guidelines for physical activity and sedentary behavior. Geneva: World Health Organization, 2020.
- 2 Piercy KL, Troiano RP, Ballard RM, et al. The physical activity guidelines for Americans. *JAMA* 2018; **320**: 2020–28.
- 3 Saint-Maurice PF, Graubard BI, Troiano RP, et al. Estimated number of deaths prevented through increased physical activity among US adults. *JAMA Intern Med* 2022; **182**: 349–52.
- 4 Ekelund U, Tarp J, Ding D, et al. Deaths potentially averted by small changes in physical activity and sedentary time: an individual participant data meta-analysis of prospective cohort studies. *Lancet* 2026; **407**: 339–49.
- 5 Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications Inc accelerometer. *Med Sci Sports Exerc* 1998; **30**: 777–81.
- 6 Matthews C, Keadle S, Berrigan D, et al. Influence of accelerometer calibration approach on MVPA estimates for adults. *J Phys Act Health* 2018; **15**: S109.
- 7 Crouter SE, DellaValle DM, Haas JD, Frongillo EA, Bassett DR. Validity of ActiGraph 2-regression model, Matthews cut-points, and NHANES cut-points for assessing free-living physical activity. *J Phys Act Health* 2013; **10**: 504–14.
- 8 Marcotte RT, Petrucci GJ Jr, Cox MF, Freedson PS, Staudenmayer JW, Sirard JR. Estimating sedentary time from a hip- and wrist-worn accelerometer. *Med Sci Sports Exerc* 2020; **52**: 225–32.
- 9 Matthews CE, Kozey Keadle S, Moore SC, et al. Measurement of active and sedentary behavior in context of large epidemiologic studies. *Med Sci Sports Exerc* 2018; **50**: 266–76.
- 10 Dunn J, Keadle SK, Strath SJ. Advancing physical activity metrics: a call for standardization and benchmarking in device-based data. *J Meas Phys Behav* 2025; **8**: 1–3.
- 11 Piercy KL, Vaux-Bjerke A, Polster M, et al. Call to action: contribute to the development of the third edition of the physical activity guidelines for Americans. *Transl J Am Coll Sports Med* 2024; **10**: e000275.
- 12 WHO. Measuring physical activity in adults using wearable technologies: report of a scientific meeting, June 10–12, 2025, Montreal, Canada. Geneva: World Health Organization, 2025.

Vaccine hesitancy: an evolving challenge

In 2015, WHO defined vaccine hesitancy as a “delay in acceptance or refusal of vaccines despite availability of vaccination services”.¹ More recently, it has been argued that the concept should be redefined as a “psychological state of indecisiveness that people may experience when making a decision regarding vaccination”,² thereby distinguishing hesitancy from the final vaccination decision. Indeed, although hesitancy remains an internal state of indecision preceding the behavioural outcome related to vaccination, it is the actual choice a person makes about vaccination (ie, acceptance or refusal) that represents the behaviour itself. In this view, hesitant individuals might still decide to get vaccinated—a known

phenomenon, especially in the context of the COVID-19 pandemic, when the concept of hesitant adopters emerged.³ Moreover, vaccine decision making is a dynamic process, influenced by time, place, vaccine type, and epidemiological context.⁴

From this perspective, the study by Matthew Whitaker and colleagues⁵ is a valuable contribution to investigating factors associated with the phenomenon of hesitant adopters in the setting of SARS-CoV-2 vaccination roll-out in the UK. A two-phase study was conducted: a cross-sectional analysis of reported vaccine hesitancy at baseline, using data from a massive community surveillance programme on more than 1 million participants



Halfpoint Images via Getty Images

Published Online
January 12, 2026
[https://doi.org/10.1016/S0140-6736\(25\)02601-7](https://doi.org/10.1016/S0140-6736(25)02601-7)
See [Articles](#) page 350

(from January, 2021, to March, 2022), followed by a longitudinal analysis of vaccine uptake in the hesitant cohort. Sociodemographic data showed that the study population was predominantly female (643 484 women vs 494 415 men) and of White ethnicity, with less than 10% of respondents belonging to other ethnicities (reported as Black, Asian, Mixed, or Other, with the latter category including Arab, any other ethnic group, or undeclared ethnicity). 55·6% of participants were older than 54 years, and 52·6% resided in less deprived areas (ie, Index of Multiple Deprivation quintiles 4 and 5).

Overall, 3·3% of participants showed hesitancy, with higher rates reported in early 2021 (8·0%), followed by a decline at the start of 2022 (to 1·1%) and a slight rebound in early 2022 (to 2·2%). Interestingly, 15 744 (65%) of 24 229 hesitant individuals received at least one vaccine dose during the longitudinal study period, confirming that hesitancy does not always imply refusal. The study addressed and confirmed well-known predictors of hesitancy related to socioeconomic disadvantages⁶ and identified sex-specific and age-specific categories of hesitancy reasons. Adjusted logistic regression models showed that hesitant adoption was more likely in younger, less socioeconomically deprived people, women who were pregnant or breastfeeding at the time of survey, and in people belonging to Asian or Other ethnic groups. The most frequent categories of hesitancy reasons—related to effectiveness and health concerns—declined with time and were not significantly associated with the odds of later vaccination. However, hesitancy reasons related to low trust and risk perception and general anti-vaccine sentiment were more resistant and were strongly associated with persistent vaccine refusal.

Study limitations include systematic bias secondary to self-reporting, selection bias due to vaccine-hesitant responders being less likely to consent to vaccination data linkage, and absence of temporal assessment of vaccination relative to eligibility or COVID-19 history. Nonetheless, the research provides unique results to study different categories of hesitancy reasons and their role in influencing vaccination behaviour in a relevant number of enrolees.

Indeed, whereas previous research had already focused on the quantification of hesitant adoption in the setting of SARS-CoV-2 vaccination⁷ and explored reasons behind the phenomenon in small samples,⁸ the present study allowed

two categories of hesitancy reasons to be distinguished—ie, modifiable and persistent motivations. Although the former are likely time limited or manageable by means of tailored communication strategies, they need to be addressed in a timely manner as they can slow vaccine roll-outs. However, interventions targeting persistent hesitancy imply a need for more complex management. From a public health perspective, although individuals with health concerns can benefit from communication with health-care providers, hesitancy driven by a priori anti-vaccine sentiment and mistrust in health-care institutions is more deeply rooted. Consequently, macro-level interventions are needed to address the complexity of these causes.⁹ It is also essential to investigate possible additional reasons for vaccine acceptance or persistent refusal in hesitant individuals through structured follow-up interviews, aiming at identifying other intervening factors that can be targeted by public health interventions. Furthermore, whereas these data reflect the extraordinary setting of SARS-CoV-2 vaccination, it is crucial to ascertain whether similar drivers of hesitancy affect ordinary (ie, routine or seasonal) vaccinations, in order to guide context-specific public health interventions at the micro, meso, and macro levels.¹⁰

We declare no competing interests.

Claudia Palmieri, *Silvio Tafuri
silvio.tafuri@uniba.it

Interdisciplinary Department of Medicine, University of Bari Aldo Moro, 70124 Bari, Italy (CP, ST)

- 1 WHO. Summary WHO SAGE conclusions and recommendations on vaccine hesitancy. January, 2015. <https://www.who.int/docs/default-source/immunization/demand/summary-of-sage-vaccinehesitancy-en.pdf> (accessed Dec 15, 2025).
- 2 Bussink-Voorend D, Hautvast JLA, Vandeberg L, Visser O, Hulscher MEJL. A systematic literature review to clarify the concept of vaccine hesitancy. *Nat Hum Behav* 2022; **6**: 1634–48.
- 3 Willis DE, Moore R, Purvis RS, McElfish PA. Hesitant but vaccinated: lessons learned from hesitant adopters. *Vaccine* 2024; **42**: 126135.
- 4 Larson HJ. Defining and measuring vaccine hesitancy. *Nat Hum Behav* 2022; **6**: 1609–10.
- 5 Whitaker M, Elliott J, Gerard-Ursin I, et al. Profiling vaccine attitudes and subsequent uptake in 1·1 million people in England: a nationwide cohort study. *Lancet* 2026; published online Jan 12. [https://doi.org/10.1016/S0140-6736\(25\)01912-9](https://doi.org/10.1016/S0140-6736(25)01912-9).
- 6 Terry E, Cartledge S, Damery S, Greenfield S. Factors associated with COVID-19 vaccine intentions during the COVID-19 pandemic: a systematic review and meta-analysis of cross-sectional studies. *BMC Public Health* 2022; **22**: 1667.
- 7 Siegler AJ, Luisi N, Hall EW, et al. Trajectory of COVID-19 vaccine hesitancy over time and association of initial vaccine hesitancy with subsequent vaccination. *JAMA Netw Open* 2021; **4**: e2126882.
- 8 Moore R, Purvis RS, CarlLee S, et al. Understanding vaccination among hesitant adopters of the COVID-19 vaccine using the increasing vaccination model. *J Health Commun* 2023; **28**: 458–76.
- 9 The Lancet Respiratory Medicine. Public trust: the vaccine against vaccine hesitancy. *Lancet Respir Med* 2025; **13**: 1041.
- 10 European Centre for Disease Prevention and Control. Promoting vaccination acceptance and uptake. April 28, 2025. <https://www.ecdc.europa.eu/en/immunisation-and-vaccines/communication> (accessed Dec 15, 2025).