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SYNOPSIS

Review of "Effectiveness of Public Health Measures in Reducing the Incidence of COVID-19, SARS-CoV-2 transmission, and COVID-19 Mortality: Systematic Review and Meta-analysis"

12/23/21

Article citation: Talic S, Shah S, Wild H, Gasevic D, Maharaj A, Ademi Z, et al. Effectiveness of public health measures in reducing the incidence of COVID-19, SARS-CoV-2 transmission, and COVID-19 mortality: systematic review and meta-analysis. BMJ. 2021;375:e068302. Available from: https://doi.org/10.1136/bmj-2021-068302

One-minute summary

- The authors conducted a systematic review of evidence examining the effectiveness of various public health interventions for reducing coronavirus disease 2019 (COVID-19) incidence, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission and COVID-19 mortality. A total of 72 studies were included in the final synthesis, 35 assessed individual public health interventions and 37 assessed multiple public health interventions implemented as a package.
- Due to the heterogeneous outcome measures reported by included studies, meta-analysis was only possible for few studies with consistent reported measures (i.e., odds ratios or relative risks [RR] with corresponding confidence intervals [CI]) which could be statistically combined. The remaining studies for which meta-analysis was not appropriate were synthesized narratively.
- Eight studies were included in the meta-analyses of three individual public health measures' effectiveness for reducing COVID-19 incidence.
    - Six studies, four with moderate risk of bias and two with serious-critical risk of bias, with a total 389,228 participants (2,627 infected with SARS-CoV-2) assessed **mask wearing**: the pooled RR = 0.47 (95% CI: 0.29, 0.75; I^2=84%), an estimated 53% reduction in COVID-19 incidence.
    - Five studies, four with moderate risk of bias and one with serious-critical risk of bias, with a total 108,933 participants (2,727 infected with SARS-CoV-2) assessed **physical distancing**: pooled RR = 0.75 (95% CI: 0.59, 0.95; I^2=87%), an estimated 25% reduction in COVID-19 incidence.

    - Three studies, two with moderate risk of bias and one with serious-critical risk of bias, with a total 10,345 participants (292 infected with SARS-CoV-2), assessed **handwashing:** pooled RR = 0.47 (95% CI: 0.19, 1.12; I^2=12%), an estimated 53% reduction in COVID-19 incidence. Of note, the CI for this result includes 1, therefore does not achieve statistical significance.

- Meta-analysis was not possible for select studies assessing mask wearing and physical distancing, as well as studies investigating other individual public health measures, these results were synthesized narratively.

    - **Mask wearing** was assessed in five studies not included in the meta-analysis, all with moderate risk of bias ratings. Overall these studies found mask wearing to be associated with reduced COVID-19 incidence, SARS-CoV-2 transmission and COVID-19 mortality. Most compared jurisdictional regions or time periods when mask wearing was mandatory versus not mandatory, and one cross-sectional study collected self-reported data related to mask wearing.

    - **Physical distancing** was assessed in three studies not included in the meta-analysis, two received moderate risk of bias ratings and one received serious-critical. These generally reported positive effects of physical distancing on reducing SARS-CoV-2 transmission and COVID-19 mortality. Study designs included a natural experiment, a quasi-experiment and a cross-sectional study.

    - **Household disinfection** was assessed in one retrospective cohort study with moderate risk of bias, which found an association between self-reported daily use of chlorine or ethanol-based disinfectant in households and reduced SARS-CoV-2 transmission.

    - **Stay at home or isolation measures** were assessed in four studies, one received a low risk of bias rating and the other three were rated moderate to serious or critical. All four reported reductions in SARS-CoV-2 transmission as a result of isolation measures. Designs included a retrospective cohort study, a natural experiment and two cross-sectional studies.

    - **Quarantine** was assessed in two cohort studies with low and moderate risk of bias ratings. One Saudi Arabia study assessed COVID-19 incidence eight weeks after implementation of mandatory quarantine for returning travellers, and a study in India compared a period of no quarantine to strict home quarantine in an unspecified population. Results found decreases in SARS-CoV-2 transmission in travellers and decreased COVID-19 incidence after home quarantine was implemented.

    - **School closures** were assessed in five studies, all with moderate risk of bias. Three United States (US) studies included evidence of school closures (implemented at state levels) being associated with reduced SARS-CoV-2 transmission, COVID-19 incidence and COVID-19 mortality. One study in Japan found no significant effect of nation-wide school closures on COVID-19 incidence. A Swedish study reported impacts of schools remaining open, and found slight increases in SARS-CoV-2 infections in parents, and that infections were more likely in secondary school teachers compared to elementary school teachers.

    - **Business closures** were assessed in two studies with moderate risk of bias ratings, both US based natural experiment studies reported reductions in SARS-CoV-2 transmission following business closures.

    - **Universal lockdowns** were assessed in 10 studies, risk of bias was low in two studies, moderate in seven and high in one. All reported some level of reduction in COVID-19 incidence, mortality, and SARS-CoV-2 transmission. Study designs included natural experiments and quasi-experiments.

    - **Restricted travel and border closures** were assessed in two studies, the first with serious-critical risk of bias and the second with moderate risk of bias. First, a natural experiment study involving nine African countries reported increases in COVID-19 incidence following border closures, whereas one US natural experiment reported a decrease in SARS-CoV-2 transmission after restricting travel between states.

    - **Entry and exit screening for fever** was assessed in one retrospective cohort study with moderate risk of bias. Results found screening for fever (setting and population not specified) had poor sensitivity for detecting people with SARS-CoV-2 infections when tested 24 hours later, estimating up to 86% of SARS-CoV-2 infections remain undetected when screening for fever.

- Multiple public health interventions implemented as a package were investigated in 37 observational studies which are briefly summarized in this review. Meta-analysis was not possible. Outcome measures varied between studies, and authors described overall effectiveness by reporting the percentage difference (i.e., reduction) in outcomes before and after implementation, or between regions compared in the studies.

    - Eleven studies found reductions between 26-50% in SARS-COV-2 transmission and COVID-19 incidence; nine studies found reductions between 51-75% in SARS-COV-2 transmission, COVID-19 incidence and COVID-19 mortality; and 14 studies found a reduction >75% in SARS-COV-2 transmission, COVID-19 incidence and COVID-19 mortality.

    - In the paper's supplementary file, the authors present a table listing estimated effectiveness of package interventions from each study (e.g., border closures, lockdowns, school closures, etc.), which indicates varying levels of effectiveness for similar packages implemented in different settings.

- The authors concluded based on meta-analyses, there are benefits of physical distancing, mask wearing and handwashing (though meta-analysis results were non-significant for handwashing), for reducing COVID-19 incidence. Narrative synthesis results indicate nearly all individual interventions and packages of public health interventions provide some beneficial effects on reducing transmission of SARS-CoV-2, COVID-19 incidence or COVID-19 mortality. Travel and border restrictions, and screening for fever have insufficient evidence to determine effectiveness.

Additional information

- The systematic review and meta-analysis followed a registered *a priori* protocol and reporting of findings was in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

- Studies excluded from this review were: case reports, case studies, modelling and simulation studies, studies with graphical summaries but no clear statistical assessments or outputs, ecological studies with descriptive outcome measures without assessing linearity or having comparators, non-empirical studies (e.g., commentaries, editorials, government reports), reviews, articles investigating only non-SARS-CoV-2 pathogens, and articles not published in English.

- Duplicate independent risk of bias assessments were conducted and appraisal items are reported for each included study. Authors note moderate to severe risk of bias across most included studies. Confounding variables were challenging to control for in natural setting studies during the COVID-19 pandemic when multiple public health interventions were implemented at the same time.

- Of 35 studies assessing individual interventions, only one randomized controlled trial (RCT) was identified and the other 34 studies were observational in design. Using the risk of bias in non-randomised studies of interventions (ROBINS-I) tool for observational studies, risk of bias was low in three studies, moderate in 24 studies, and high-serious in seven studies. Using the Risk of Bias 2 (ROB-2) tool, risk of bias was moderate for the RCT.

- Of 37 observational studies assessing multiple public health interventions implemented as a package, risk of bias was low in two studies, moderate in 31 studies, and high-serious in four studies using the ROBINS-I tool.

PHO reviewer's comments

- A comprehensive search strategy was conducted however it is worth noting the search was last updated in June of 2021. Most included studies were conducted in 2020 before COVID-19 vaccination was widely implemented across populations, before Delta became the dominant strain and before the emergence of Omicron. The authors acknowledge further research will be needed to determine effectiveness of public health interventions after adequate vaccination coverage is achieved, and that emerging variants may also impact transmission.

- This detailed systematic review and meta-analysis identified few high quality or prospective and controlled studies of public health interventions which limits the certainty in the point estimates presented. Notably, there were no studies evaluating ventilation, air filtration or test-to-stay strategies as public health interventions.

- While a detailed independent risk of bias assessment is conducted for each included study, an overall quality of evidence assessment at the outcome level (such as a GRADE assessment) is not formally conducted. Based on nearly all evidence being drawn from observational studies, high heterogeneity across studies' designs and outcome measures, and the majority of individual studies being rated at moderate-high risk of bias, the level of certainty in this body of evidence would likely be considered low or very low.[1] Authors do acknowledge in the limitations that findings are likely to be updated as new and higher quality evidence becomes available.

- Descriptions of limitations beyond the risk of bias rating for each study are not explored in detail in this review, however should be kept in mind when interpreting results of any synthesis. Confounding variables are acknowledged by Talic et al. (2021) as a common limitation across studies, and this should be emphasized for the reported results of individual interventions because it is unlikely for a single public health intervention to be truly implemented in isolation during the COVID-19 pandemic. For example, upon review of the studies included for the individual intervention of school closures, limitations reported by primary study authors included but are not limited to: possible inappropriate choice of linear trend model for the pandemic context; inability to single out the effects of school closures from other public health interventions; not accounting for confounders such as hygiene and air pollution; and uncertainty around testing strategies for studies using data from regional public health testing or outcome information databases.[2-6]

- The estimated 53% risk reduction associated with handwashing, while non-significant, may be considered unexpected given the understanding that SARS-CoV-2 is predominantly spread via inhalation of respiratory particles rather than through fomites.[7,8] Glasziou et al. (2021) suggest in a commentary discussing this review that handwashing may serve as a marker for other personal health behaviours such as avoiding crowds, physical distancing and mask wearing.[1]

- It may be reasonable to expect that most public health interventions intended to reduce the impact of SARS-CoV-2 and COVID-19 will have at least a partial beneficial effect. While it is useful to see this review's results generally supporting this, application of these findings may be limited without more readily comparable effectiveness results across outcomes and interventions, and without careful benefit-harm considerations. In addition, it has been demonstrated throughout the pandemic that multiple layered prevention measures are key to effective mitigation.[9]

- Factors that are important to consider when implementing widespread public health measures are the potential inequitable health and social harms or benefits for certain populations over others (e.g., people who work in environments where physical distancing is not possible; school closures disproportionately harming children, families and women; price of masks for members of the general public; economic impacts on businesses; etc.). Talic et al. (2021) do acknowledge that, for example, despite evidence of reduced COVID-19 mortality following universal lockdowns, this is an unsustainable intervention and the population's adherence and compliance with public health measures is key to effective and sustainable interventions.

- The authors provide a relatively brief summary of the multiple intervention package studies, indicating most studies found >25% differences in overall effectiveness of package interventions. Package interventions are not described in detail, though supplementary summary tables show varying levels of effectiveness of similar packages (e.g., school and workplace closures) when applied in different study settings. There may have been a role for the authors to explore these discrepancies in the narrative results or discussion sections.

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Citation

Ontario Agency for Health Protection and Promotion (Public Health Ontario). Review of "Effectiveness of public health measures in reducing the incidence of COVID-19, SARS-CoV-2 transmission, and COVID-19 mortality: systematic review and meta-analysis". Toronto, ON: Queen's Printer for Ontario; 2021.

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