

Commentary on Education in Occupational Health

Cross-sectional studies in occupational health research: An overview of strengths and limitations

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Abstract

Cross-sectional study design, a prominent aspect of observational research, facilitates the simultaneous assessment of outcomes and exposures among study participants. Unlike case-control or cohort studies, cross-sectional investigations select participants based on predetermined inclusion and exclusion criteria rather than outcome or exposure statuses. Once the participant cohort is established, the study evaluates exposure and outcome relationships. This design finds application in population-based surveys and the assessment of disease prevalence within clinic-based samples. The efficiency and cost-effectiveness of cross-sectional strategies make them appealing for preliminary data collection before embarking on cohort studies, thus providing a foundational basis for subsequent cohort study planning. While offering insights into outcome and exposure prevalence, the inherent limitation of single-time exposure and outcome measurement in cross-sectional analysis hinders establishing causal relationships. Nevertheless, cross-sectional studies enable the estimation of disease prevalence and odds ratios, facilitating the exploration of exposure-outcome associations. This paper comprehensively elucidates the utilization of cross-sectional studies in occupational health, emphasizing strengths and limitations and highlighting their significance in shaping research methodologies and informing future investigations in this discipline.

Key words: cross-sectional study; occupational health surveillance; research.

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INTRODUCTION

Occupational health research is integral to safeguarding the workforce's well-being and enhancing public health. The pursuit of comprehensive understanding within this realm necessitates deploying methodological tools illuminating prevailing health conditions and unraveling intricate associations between various occupational exposures and health outcomes. In this context, cross-sectional study design emerges as a pivotal instrument, offering unique insights into the complex interplay between exposures and outcomes within a defined population.

The dynamic nature of occupational environments, characterized by diverse hazards, demands research methodologies to efficiently capture the current health status and prevalent exposure among workers. Cross-sectional studies, with their simultaneous evaluation of outcomes and exposures, offer a pragmatic approach to achieving this objective. By selecting participants based on predetermined inclusion criteria rather than outcome or exposure statuses, these studies provide a snapshot of the existing landscape, allowing researchers to discern patterns, prevalence, and potential associations.

The pragmatic appeal of cross-sectional designs lies in their ability to amass data swiftly and cost-effectively, making them invaluable tools for preliminary assessment before embarking on more resource-intensive cohort studies. Such methods facilitate the estimation of disease prevalence and odds ratios, enabling researchers to unravel the threads linking exposures to outcomes.

Nonetheless, the inherent limitation of single-time exposure and outcome measurements poses challenges in establishing causal relationships, emphasizing the need for a nuanced interpretation of findings. This paper explores the strengths and limitations of cross-sectional design in occupational health research, shedding light on their methodological underpinnings, applications, and implications. By navigating through the intricacies of cross-sectional design, I aim to equip researchers, practitioners, and policymakers with a comprehensive understanding of how this approach can contribute to advancing occupational health knowledge. As I embark on this exploration, I aspire to uncover the multifaceted tapestry of prevalence and associations that define the landscape of occupational health, ultimately fostering informed decision-making and proactive intervention strategies for a healthier, safer workforce.

DISCUSSION

Limitations of cross-sectional studies in occupational health research: Navigating challenges and enhancing interpretation

Cross-sectional studies have emerged as valuable tools in occupational health research because they provide a snapshot of prevailing health conditions and exposures within a specific population. However, it is crucial to recognize and navigate the inherent limitations of this study design to ensure accurate interpretation of findings and to guide the formulation of informed conclusions. In the context of occupational health research, several critical limitations of cross-sectional studies warrant consideration:

Temporal ambiguity and causality

One of the primary limitations of cross-sectional studies is their inability to definitively establish causal relationships between occupational exposures and health outcomes. As data is collected at a single time point, it becomes challenging to discern the directionality of the association. This limitation hampers the ability to definitively conclude whether a specific exposure led to a particular health outcome or vice versa.

Longitudinal designs are better suited for elucidating temporal relationships and inferring causality.

The limitation of temporal ambiguity and causality in cross-sectional studies is particularly relevant in occupational health psychology due to the intricate interplay between work-related factors, psychological well-being, and health outcomes. Occupational health psychology focuses on understanding how work environments, job demands, stressors, and organizational factors impact

individuals' mental and physical health. In this context, establishing causal relationships is crucial for guiding interventions, designing workplace policies, and improving overall well-being.

Cross-sectional studies in occupational health psychology often assess variables like job stress, job satisfaction, burnout, psychological distress, and physical health outcomes among workers. While these studies can provide valuable insights into the prevalence of specific conditions and associations between variables, they often fail to establish whether the observed relationships are genuinely causal [1].

For example, consider a cross-sectional study that finds a significant association between high job stress and increased levels of psychological distress among employees. While this association suggests a link between stress and mental health, the cross-sectional design cannot determine whether job stress led to psychological distress or if individuals with higher distress were more likely to perceive their jobs as stressful. Longitudinal studies, which track participants over time, would be better equipped to unravel the temporal sequence of events and provide more robust evidence for causality. Although causality remains a debated topic, with diverse approaches such as the counterfactual "potential outcome approach" and the "pluralistic approach," the viewpoints offer a foundational framework for researchers [1,2].

The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach is a systematic and transparent approach for rating the certainty of evidence in systematic reviews and clinical practice guidelines and for developing and determining the strength of clinical practice recommendations [3]. While GRADE originated from healthcare assessment and typically favors Randomized Controlled Trials (RCTs), it also considers observational studies, albeit with a "low quality" rating. However, adjustments, both upgrades, and downgrades, can be made to this rating. On the other hand, RCTs under GRADE start with a "high quality" rating [2]. Some scholars have proposed that the "Navigation Guide," a newer method used for systematic review evidence synthesis that initially stemmed from environmental studies and is now utilized in occupational health research, suggests a different approach. In this method, observational studies start with a "moderate" rating, which can then be adjusted upwards or downwards [4-6].

This perspective acknowledges the value of observational studies in generating knowledge and guiding decision-making, especially in occupational health areas where randomized controlled trials may be impractical or unethical [7].

Recall and reporting bias

Cross-sectional studies often rely on self-reported participant data, introducing the potential for recall bias and reporting inaccuracies. Participants may not recall past exposures or health events accurately, leading to underestimating or overestimating associations. Furthermore, subjective interpretations of symptoms or health conditions can vary among individuals, influencing the reliability of reported outcomes.

Selection bias and generalizability

While based on predefined criteria, the participant selection process in cross-sectional studies may inadvertently introduce selection bias. Individuals who choose to participate may differ in important ways from those who decline, leading to a skewed representation of the population. This feature can limit the generalizability of study findings to broader occupational or demographic groups.

Confounding variables

Cross-sectional studies may struggle to account for the influence of confounding variables—factors associated with both the exposure and outcome of interest. Failure to adequately control for confounding variables can lead to spurious associations or masking of genuine relationships. While statistical techniques can mitigate confounding to some extent, they may not eliminate its impact.

How the "Healthy Worker Effect" affects cross-sectional studies in occupational health research

While initially recognized in 1885, it's only over the past forty years that the healthy worker effect (HWE) has been thoroughly investigated. The "healthy worker effect" (HWE) is a phenomenon observed in occupational health research where workers in a given occupation tend to be healthier on average than the general population. This distinctive selection bias, prevalent in occupational cohort studies, has spurred extensive discussions regarding its influence, classification (as confounding, selection bias, or both), and methods to mitigate its effects. Notably, this bias isn't limited to cohort studies; it also influences cross-sectional studies [8]. In the context of cross-sectional studies, the HWE can introduce biases and affect the interpretation of findings. The primary concern is that the healthy worker effect can lead to underestimating the actual risks associated with occupational exposures. If the working population is healthier than the general population, then the relative risk associated with a particular occupational exposure might appear lower than it truly is. Without accounting for the HWE, researchers might erroneously conclude that occupational exposure has no health risks or seemingly protective effects, which may be harmful. When comparing health outcomes across different occupational groups, the HWE can distort comparisons. Some groups may exhibit a stronger HWE than others, leading to incorrect conclusions about the relative risks of different occupations. The results of occupational health studies affected by the HWE might not be generalizable to other populations, especially those outside the workforce.

For this reason, researchers should be aware of the potential for HWE. Instead of comparing to the general population, it might be more appropriate to compare workers with different levels of exposure or use other methods like internal comparisons among the same group. Furthermore, some statistical techniques can be used to adjust for potential confounding factors associated with the HWE. Finally, cohort studies that follow individuals over time can help mitigate some of the effects of the HWE, especially when understanding attrition due to health reasons.

Dynamic nature of exposure

Occupational exposures are often dynamic and can change over time due to workplace interventions, policy changes, or individual behaviors. Cross-sectional studies, capturing data at a single point, may not capture these variations accurately. This limitation can affect the accuracy of exposure assessment and may lead to misinterpretation of associations.

Prevalence vs. incidence

Cross-sectional studies are better suited for estimating the prevalence of health outcomes and exposures within a population rather than determining incidence rates or cumulative risks. Incidence, a critical measure in occupational health, reflects the new cases of a health outcome over a defined period, necessitating longitudinal designs.

In navigating these limitations, researchers conducting cross-sectional studies in occupational health must exercise caution in interpreting their results. While cross-sectional designs offer valuable insights into prevalence and associations, they should be complemented by other study designs, such

as longitudinal studies and quasi-experimental interventions, to provide a more comprehensive understanding of the complex dynamics between occupational exposures and health outcomes. Awareness of these limitations serves as a guidepost for refining methodologies and advancing the field of occupational health research.

Strengths of cross-sectional studies in occupational health research: Harnessing insights and shaping strategies

Cross-sectional studies have unique strengths that position them as indispensable tools in occupational health research. By offering a comprehensive snapshot of prevailing health conditions and exposures within a defined population, cross-sectional designs contribute significantly to our understanding of the complex interplay between occupational factors and health outcomes. In the context of occupational health research, several critical strengths of cross-sectional studies stand out:

Efficiency and timeliness

Cross-sectional studies are known for their efficiency in data collection and analysis. With data gathered at a single point, these studies expedite the research process, making them particularly advantageous for assessing the current health status and exposures within diverse occupational settings. This efficiency is vital for generating timely insights that inform workplace interventions and public health strategies.

Generating hypotheses and identifying patterns

Cross-sectional studies are valuable for generating hypotheses and identifying potential associations between occupational exposures and health outcomes. Researchers can formulate preliminary hypotheses that guide subsequent, more in-depth investigations using longitudinal or quasi-experimental designs by examining prevalence rates and exploring relationships between various factors.

Cost-effectiveness

The cost-effectiveness of cross-sectional studies is a notable advantage. These studies often require fewer resources than longitudinal designs, making them accessible options for researchers and organizations with limited budgets. This affordability allows for collecting data from more extensive and diverse participant samples, enhancing the external validity of findings.

Indeed, the cost-effectiveness of cross-sectional studies in occupational health research is a significant advantage that can be particularly pronounced when mandatory occupational health programs are in place. Often established for specific exposures or industries, these programs can provide an ideal environment for conducting cross-sectional studies that yield valuable insights while optimizing resource allocation.

Mandatory occupational health programs typically require workplaces to monitor and address specific exposures or health risks to ensure the well-being of employees. These programs create a structured framework that facilitates data collection, participant recruitment, and compliance with research protocols. Researchers can leverage these existing structures to capitalize on the readily available data and infrastructure, leading to cost savings and streamlined study implementation.

Population-based insights

Cross-sectional studies offer a population-based perspective, providing insights into the distribution of health outcomes and exposures across diverse groups. This broad view is precious in occupational health research, where understanding variations in exposures and outcomes among

different job roles, industries, and demographic groups can inform targeted interventions and policies.

Generating prevalence estimates

The prevalence of specific health outcomes and exposures can be estimated accurately through cross-sectional studies. This information is vital for assessing the burden of occupational diseases, identifying emerging health issues, and prioritizing resource allocation for preventive measures and interventions.

Planning and resource allocation

Cross-sectional studies play a strategic role in the planning and designing subsequent research endeavors. They provide preliminary data that guide the formulation of research questions, selection of appropriate variables, and determination of sample sizes for more complex longitudinal or interventional studies.

Informing public health interventions

The insights from cross-sectional studies can inform the development of evidence-based public health interventions and policies. By identifying prevalent health issues and their associated risk factors, these studies guide allocating resources toward targeted interventions to improve occupational health and well-being.

Causality and responsibility in occupational health

This work delves into the complex relationship between causality and responsibility within occupational health. While epidemiology rigorously analyzes causality, there is sometimes a narrow focus on purely biomedical causes, overlooking broader economic and political factors. Effective governance is required, where administrations, businesses, and governments take responsibility by implementing policies, many legally based. These policies should result from inclusive, democratic processes, which sometimes can be prolonged and overlook those suffering. To truly understand the journey from health to illness, there's a need for a holistic view, encompassing both scientific evidence and political responsibility, mainly focusing on protecting the most vulnerable [9].

Harnessing real-world data: The evolution and challenges in occupational health surveillance

The advent of technology, combined with the widespread accessibility of digital tools like computers and smartphones, has dramatically transformed the landscape of clinical research data collection. This transformation has given rise to a surge in "real-world data" that encapsulates authentic patient experiences beyond the confines of structured clinical trials. This rich, detailed data acts as a valuable complement to traditional randomized clinical trials, increasingly shaping health decisions. Yet, with these advantages come notable challenges. The inherent nature of real-world data presents obstacles in analyzing cluster-correlated information, filling in missing data gaps, and navigating the specificities of longitudinal data [10]. These complexities are deeply recognized in academia, leading to various methodologies like mixed models and imputation methods to address them. This becomes especially salient when considering data gathered by occupational physicians during occupational health surveillance. Their data, often real-world and longitudinal, necessitates intricate analytical tools to ensure proper interpretation and maximize its utility in occupational health.

Implications for researchers and occupational stakeholders

The utilization of cross-sectional studies in occupational health research carries profound implications for both researchers and occupational stakeholders. Researchers benefit from these studies as invaluable stepping stones, enabling the generation of preliminary insights and hypotheses that inform the design of more extensive longitudinal investigations and interventions. By identifying prevalent health conditions and associations between exposures and outcomes, cross-sectional studies guide the strategic allocation of resources, optimizing the effectiveness of subsequent research endeavors. Occupational stakeholders, including employers, policymakers, and public health officials, can leverage the findings of cross-sectional studies to formulate evidence-based strategies to improve workplace conditions, safeguard employee health, and foster a culture of well-being. These studies foster a symbiotic relationship between research and practice, nurturing a cycle of informed decision-making that contributes to healthier, safer work environments.

CONCLUSION

In conclusion, cross-sectional studies in occupational health research offer a range of strengths that contribute significantly to our understanding of the complex relationships between occupational exposures and health outcomes. Their efficiency, cost-effectiveness, and ability to generate hypotheses make them indispensable tools for generating preliminary insights, guiding intervention strategies, and informing subsequent research endeavors. While acknowledging their limitations, researchers and practitioners can leverage the strengths of cross-sectional studies to enhance occupational health knowledge and promote the well-being of workers worldwide.

In the tapestry of occupational health research, cross-sectional studies weave a vital thread, offering a snapshot of prevailing health conditions and exposures that shape the well-being of workers. As we navigate the strengths and limitations of this study design, it becomes evident that cross-sectional studies are pivotal tools for hypothesis generation, prevalence estimation, and early intervention planning. Their efficiency, affordability, and ability to identify associations pave the way for deeper explorations, guiding researchers toward comprehensive understanding. By illuminating the intricate connections between occupational exposures and health outcomes, cross-sectional studies empower researchers, practitioners, and stakeholders to collaboratively craft strategies that foster healthier workplaces, enhance public health, and ultimately contribute to the betterment of individuals and communities alike. However, it is paramount that researchers remain vigilant about the inferences drawn from such studies, respecting the guidelines and considerations borne from years of methodological debates and advancements [7].

As we continue to harness the insights offered by cross-sectional studies, we stand poised to forge a future where occupational health is elevated to new heights of knowledge and well-being.

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