Advancement of Epidemiological Methods

Melbourne Institute of Business and Technology

Generally, due to its role in the description and analysis of disease occurrence patterns, disease risk factors and healthcare interventions, epidemiology is widely regarded as a strong supporting factor for research on healthcare outcomes, with a specific focus on public health (Binns *et al.*, 2020). More specifically, epidemiology facilitates the development of interventions which are aimed at disease control and prevention, thus in turn leading to improved healthcare outcomes for the general public. Over time, the advancement of epidemiologic methods has led to outcomes such as improved causative outbreak explanations and interventions, which are in turn particularly responsible for infectious disease management. For instance, Seemann *et al.* (2020) explains that in view of the COVID-19 pandemic, epidemiologic research facilitated the development of healthcare responses that resulted in the recovery of over 16,000 individuals. However, in light of the ever-changing nature of factors such as the pharmacoepidemiology, and genetic and molecular epidemiology, there is need for constant improvement of epidemiologic methods. This improvement is in reference to environmental issues, demographic aging, global health and the epidemiology of infectious diseases, which play a significant role in the determination of overall human health. Consequently, it is evident that while advancements in epidemiology have led to improved health outcomes, the analysis of dynamic factors in its framework will facilitate the development of recommendations which will allow for constant methodological advancement.

Epidemiology can be described as a science through which disease distribution, risk factors and determinants are studied within a population (Firth *et al.*, 2020). As such, the advancement of epidemiological methods results in the achievement of higher levels of accuracy in disease prevention and diagnosis, thus in turn resulting in improved control of infections. Generally, incidence rates are the major foundational element for inference development in

epidemiology. More specifically, incidence rates determination revolves around the creation of a relationship between the occurrence of diseases and specific time spans, as well as the demographic of affected individuals. An instance of the application of incidence rates in epidemiology can be seen in the study conducted by Haley *et al*. (2014), which featured the analysis of data collected from around 130,000 patients from 270 healthcare institutions. Based on the results collected during this study, the validity of the relationship between the rate of disease infection and specific groups of patients within specified time frames is clear.

While incidence rates are a significant supporting factor for epidemiological advancement, numerous issues are often encountered in the creation of large databases of information on substantial numbers of individuals. Analysis of existing research reveals that this particular issue has led to the adoption of epidemiological studies that are based on case control (von Ehrenstein *et al*., 2019). Although case control and cohort studies account for most of the study designs that are aimed at epidemiological advancement, the recent incorporation of meta-analysis and systematic reviews has introduced the concepts of existing data analysis and statistical comparison of various studies for the enhancement of the framework of epidemiology. The overall applicability of these methods is evident through their determination of the need for infection control policy adherence by healthcare workers (Murad & Wang, 2017). Essentially, this implies that although the application of advanced epidemiological methods has successfully led to the creation of policies to mitigate the spread of diseases through guided healthcare provision, the existing low levels of adherence to these policies by healthcare workers presents a major issue to public health. Consequently, it is evident that while the application of traditional study designs has been beneficial to public health, the analysis of existing data through the

adoption of newer methods of analysis is expected to play a significant role in the identification

of exiting issues in disease control.

In addition to enhanced incident rate analysis, advanced epidemiological methods are

also directly linked to the development of enhanced causative outbreak explanations through the

generation of possible hypotheses (Dario & De Matteis, 2020). Essentially, the overall validity of

the generated hypotheses is often conducted upon the conclusion of disease outbreaks. To

illustrate, Dario and De Matteis (2020) highlight a particular case which detailed the utilisation

of epidemiologic tools within a transplantation unit for stem cells for the identification of a

correlation between the spread of Legionnaires disease and a water fountain. This correlation

was developed using the account of two patients who contracted pneumonia within the

establishment ten days after getting into contact with the water fountain. As such, through this

illustration, the overall effectiveness of advanced epidemiological methods in the identification

of disease outbreak origins and the development of measures of intervention is clear.

While advanced epidemiologic methods have been linked to the creation of enhanced

disease origin and intervention measures, they can also be directly associated with the overall

improvement of public health outcomes. To illustrate, the development of effective methods for

the cessation and prevention of smoking-related issues has been facilitated by the epidemiologic

analysis of environmental and active tobacco exposure health risks (Wang & Loeb, 2017).

Additionally, within the U.S., folic acid fortification in wheat was adopted as a means of

mitigating the risks—such as defects of neutral tubes—associated with the deficiency of folic

acid (Wang & Loeb, 2017). Moreover, along with the launch of a global campaign for

vaccination against hepatitis B due to its direct association with liver cancer, the application of

advanced epidemiological methods has also resulted in an overall reduction in the rate of deaths

caused by cardiovascular issues in relation to the lifestyle and medical management of risk factors such as smoking, hyperlipidaemia and hypertension.

With reference to the identified areas of applicability for epidemiological methods, it is clear that their continued advancement is necessary. In turn, this advancement is directly dependant on a number of fundamental factors, which include access to data, the complexity of methodologic approaches, and advocacy and communication (Wang & Loeb, 2017). Focussing on communication and advocacy, the overall public perception of the utilisation of epidemiologic methods is a significant factor in the development of evidence-based solutions to disease control and management (Wang & Loeb, 2017). With this in mind, it is necessary for epidemiologists to improve communication amongst themselves and the public, for the purpose of allowing for rapid consensus development. Essentially, the enhancement of consensus will lead to rapid hypotheses generation, thus in turn facilitating the improvement of public health on the basis of heightened disease mitigation reactions.

Comparatively, the employment of complex methodological approaches revolves around the construction of mathematical models on available data from relationships that are hypothesised from a number of theories (Ren *et al*., 2022). The resulting complex epidemiological models allow for early testing of hypotheses, thus allowing for the development of valid explanations for disease development and control. Finally, epidemiologic research is heavily dependent on access to human data. While this access is linked to potential ethical breaches of individual privacy, the advancement of epidemiologic methods is directly dependent on the creation of a mutual covenant between data collection and protection bodies, in order to allow for access to valuable public health data.

In addition to the aforementioned fundamental factors, the scientific advancement of epidemiologic methods is also associated with genetic and molecular epidemiology, as well as pharmacoepidemiology. With reference to genetic and molecular epidemiology, the methylation of DNA and epigenetic histone protein changes are important for population variation analysis due to their control of interactions between genes and the environment, proteomics and the expression of genes (Ren *et al*., 2022). Similarly, research into pharmacoepidemiologic research with particular regard to the benefits, safety signals and safety risks of various forms of medication is paramount for epidemiologic methodology advancement (Ren *et al*., 2022). This is due to the allowance for comparative examination of the medical interaction of various diseases in different demographics.

Consequently, in light of the factors linked to epidemiologic methodology advancement, a number of recommendations can be suggested for continued improvement. One such improvement is the extension of epidemiology beyond etiological research and discovery, to include research of outcomes, implementation, evaluation of interventions and multilevel analysis (Ren *et al*., 2022). Essentially, this will allow for the transformation of epidemiological practice through the improvement of access to specimens, metadata and data, thus in turn resulting in enhanced collaboration, improved replication and reproducibility, and accelerated translation of data on public health. Finally, the advancement of epidemiological methods can also be achieved through the integration of big data science to not only facilitate large-scale data management and analysis, but also allow for reductions in human error during data recording and analysis.

Summarily, epidemiologic methods are the backbone of public health management in modern society. As earlier mentioned, their overall applicability can be directly associated with a

number of fundamental factors which have a significant effect on their advancement. In turn, this advancement is important for the continued improvement of public health, particularly in light of existent and emerging diseases and infections. Ultimately, through the application of various recommendations, the continued advancement of epidemiologic methods will allow for improved outcomes in disease detection and management at a global scale.

Reference List

Binns, C., Low, W. Y., & Kyung, L. M. (2020). <? covid19?> The COVID-19 Pandemic: Public

Health and Epidemiology. *Asia Pacific Journal of Public Health*, *32*(4), 140-144.

Dario, C., & De Matteis, S. (2020). Introduction to epidemiological methods for studying effects

of exposure to pesticides.

Firth, J., Wootton, R. E., & Carvalho, A. F. (2020). Toward preventive psychiatry: the role of

advanced epidemiological methods. *American Journal of Psychiatry*, *177*(10), 888-890.

Haley, N. J., Carver, S., Hoon-Hanks, L. L., Henderson, D. M., Davenport, K. A., Bunting, E., ...

& Hoover, E. A. (2014). Detection of chronic wasting disease in the lymph nodes of free-

ranging cervids by real-time quaking-induced conversion. *Journal of clinical

microbiology*, *52*(9), 3237-3243.

Murad, M. H., & Wang, Z. (2017). Guidelines for reporting meta-epidemiological methodology

research. *BMJ evidence-based medicine*, *22*(4), 139-142.

Ren, T., Ji, Y., Zhu, Z. J., Zhang, H., Wang, P. Y., & Shi, Y. H. (2022). Application of

epidemiological methods in health impact assessment. *Zhonghua liu Xing Bing xue za

zhi= Zhonghua Liuxingbingxue Zazhi*, *43*(3), 424-430.

Seemann, T., Lane, C. R., Sherry, N. L., Duchene, S., Gonçalves da Silva, A., Caly, L., ... &

Howden, B. P. (2020). Tracking the COVID-19 pandemic in Australia using

genomics. *Nature communications*, *11*(1), 1-9.

von Ehrenstein, O. S., Ling, C., Cui, X., Cockburn, M., Park, A. S., Yu, F., ... & Ritz, B. (2019).

Prenatal and infant exposure to ambient pesticides and autism spectrum disorder in

children: population based case-control study. *Bmj*, *364*.

Wang, B., & Loeb, M. (2017). Epidemiological Methods. In *Innate Antiviral Immunity* (pp. 263-

271). Humana Press, New York, NY.