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Introducing LTASR, a new R package based on the NIOSH Life Table Analysis System

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For over 50 years, the National Institute for Occupational Safety and Health (NIOSH) has aided epidemiologists in the analysis of occupational cohort studies with the Life Table Analysis System (LTAS) (1). LTAS simplifies person-year analyses, which is a central feature of occupational epidemiology research. LTAS is regularly utilized in occupational epidemiology studies to calculate standardized mortality and morbidity ratios (SMRs). SMRs continue to be used in occupational epidemiology to compare the mortality experience of a cohort to a national or regional population. While there are limitations to SMRs, such as the inability to evaluate a dose-response association and bias towards the null from the healthy worker effect, SMRs remain an important tool in characterizing the overall occupational experience of workers across different industries. SMRs are also an important surveillance tool in occupational and environmental settings. Many occupational cohort studies have used the NIOSH-LTAS system to conduct seminal research, such as a study of first responders to the World Trade Center disaster (2) and a study of neurodegenerative diseases among NFL players (3), among many others.

The LTAS software is no longer supported and provided by NIOSH/CDC. However, much of the functionality of LTAS can now be found within a package developed for the statistical computing software R (4) called ‘LTASR’. Developments in standard statistical software and computing power allow all the functionality of LTAS to exist in an R package with enhanced flexibility, customization, and reproducibility compared to its preceding graphical user interface versions.

LTASR maintains the core functionality of LTAS, which is to:

1. Read in cohort information such as demographic information, mortality, or morbidity information, as well as time dependent exposure history information.
2. Calculate person-time at risk in the form of person-days, based on criteria specified by the user, and stratify person-time based on dependent variables of interest. These person-time tables can also be exported for Poisson regression

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analyses to internally compare mortality rates typically across an exposure variable.

3. Analyze the stratified cohort by calculating standardized mortality ratios (SMRs) and corresponding 95% confidence intervals, that compare observed mortality rates to an external population.

The flexibility of R code facilitates additional functionality to be added over time, namely, the ability to stratify by time-dependent stratifiers such as duration of employment, calculating causal mortality ratios (CMRs), performing background stratified Poisson regression, and evaluating heterogeneity of standardized variables over time using random effects models.

Another strength of the original LTAS system was the ability to classify causes of death across many revisions of the International Classification of Diseases (ICD). LTASR includes the ability to collapse ICD codes into the 119 causes of death groupings originally used by LTAS (5) as well as includes the national referent rates from 1960–2020 for these outcomes to be used to calculate SMRs. NIOSH personnel plan to continue updating and making publicly available national level referent rates for the NIOSH 119 cause of death groupings for the 11th ICD revision which came into effect on January 1st, 2022.

There are a few drawbacks to the current proposed package. For one, use of the package requires basic familiarity with the R programming language. Second, the package requires stricter formatting of the imported cohort information by the user than was required by the original LTAS software. That is, the original LTAS utilized a graphical user interface (GUI) that provided the ability to select various options that allowed the data being read in to have a variety of formats. Third, as mentioned before, not all functionality of the original LTAS software is currently available, however the package will be continually updated. Specific information about the package, including a vignette providing more details for the use of the package, can be found on the Comprehensive R Archive Network (CRAN) website (6).

An advantage of the LTASR package compared to prior LTAS graphical user interfaces is the enhanced reproducibility of R code. Previously, LTAS.NET users could document their ‘point and click’ analytical choices in a PDF output. R code allows the user to view analytical decisions and options, program output, data, and statistical output simultaneously in the same software environment.

R statistical software and the LTASR page are free to the user. While the original LTAS software will no longer be available for download, national rate file information and documentation will continue to be available through the LTASR package as well as upon request from nioshltas@cdc.gov.

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