

# Heat stress and incidence of acute kidney injury among agricultural workers in Spain



Cristina O'Callaghan-Gordo, Lourdes Arjona, Francisco Brocal, Ben Caplin, Ana Espinosa, Rocío García, Mayte Martín-Bustamante, Claudia Malpica-Lander, Oriana Ramirez-Rubio, Elena Ronda, Neil Pearce, Manolis Kogevinas

## Abstract

**Background** Heat stress is associated with adverse health outcomes among workers, including acute kidney injury. We aimed to estimate the incidence of acute kidney injury over the course of the work shift and the association with heat stress among agricultural workers in Spain, where summer temperatures are high and heatwaves are expected to be frequent.

**Methods** Male agricultural workers were enrolled in two different harvesting seasons and provinces, as follows: summer in Alacant (n=43; September, 2018) and winter in Tarragona (n=52; November, 2018, and January, 2019). For each participant, we estimated exposure to heat stress during a work shift based on the wet bulb globe temperature (WBGT) index and acute kidney injury cross-shift incidence, defined as an increase in post-shift serum creatinine by at least 0·3 mg/dL or at least 1·5 times the pre-shift serum creatinine concentration. We collected information on confounders. For a subsample of participants (n=54), we measured neutrophil gelatinase-associated lipocalin (NGAL) concentrations before and after the working shift. We used regression models to assess if heat stress was a risk factor for acute kidney injury and increase in NGAL concentrations.

**Findings** The mean WBGT was 24·5°C (SD 2·0; range 20·2–27·1) during the summer season and 14·2°C (8·0–20·7) during the winter season. Nine (21%) of 43 workers harvesting during summer were exposed to heat stress. Incidence of acute kidney injury was higher during the summer season (14 [33%] of 43 workers vs two [4%] of 52 workers). Heat stress was associated with cross-shift incidence of acute kidney injury (age-adjusted odds ratio 9·6, 95% CI 1·4–67·9). No differences in NGAL concentrations were observed between participants exposed to heat stress.

**Interpretation** Heat stress is a risk factor for acute kidney injury among agricultural workers in Spain, even when environmental temperatures are not extreme. Monitoring acute kidney injury incidence among agricultural workers in Spain is important in the context of climate change, as frequent episodes of acute kidney injury can lead to chronic kidney disease.

**Funding** Carlos III Health Institute and European Union.

**Copyright** © 2022 The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY 4.0 license.

## Contributors

CO-G conceived the study idea, designed the research, verified and analysed the data, and wrote the abstract. LA participated in study design and data collection. FB participated in study design, verified the data, and contributed to the interpretation of results. BC participated in study design and interpretation of results. AE verified the data and participated in the interpretation of results. RG collected the data. MM-B participated in study design. CM analysed the data. OR-R participated in interpretation of results. ER participated in study design. NP participated in study design and interpretation of results. MK participated in study design and interpretation of results. All authors reviewed and revised the abstract. CO-G, AE, FB, and CM accessed and verified the underlying data.

## Declaration of interests

All authors declare no competing interests.

Correspondence to:

Dr Cristina O'Callaghan-Gordo,  
Faculty of Health Sciences,  
Universitat Oberta de Catalunya,  
08018 Barcelona  
co\_callaghang@uoc.edu