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Effect of temperature in diabetes patient

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Abstract: Diabetes is well-known as one of the many chronic diseases that affect different age groups. Currently, most studies that evaluated the effects of temperature on diabetes mortality focused on temperate and subtropical settings, but no study has been conducted to assess the relationship in a tropical setting. We conducted the first multi-city study carried out in tropical cities, which evaluated the temperature–diabetes relationship. We collected daily diabetes mortality of four Philippine cities from 2006 to 2011. Same period meteorological data were obtained from the National Oceanic and Atmospheric Administration. We used a generalized additive model coupled with a distributed lag non-linear model (DLNM) in determining the relative risks. Results showed that both low and high temperatures pose greater risks among diabetics. Likewise, the study was able to observe the: (1) high risk brought about by low temperature, aside from the largely observed high risks by high temperature; and (2) protective effects in low temperature percentile. These results provide significant policy implications with strategies related to diabetes risk groups in relation to health service and care strategies.

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Introduction: Diabetes mellitus (DM), commonly known as diabetes, is a group of metabolic diseases characterized by chronic hyperglycemia due to problems with insulin secretion, insulin action or both [1,2]. Globally, diabetes has been on the rise, and affects not just high-income countries, but has also spread and markedly increased among middle-income countries, which has claimed 1.5 million deaths [3]. In the Philippines, 4.6% of the general population have DM according to the 2003–2004 National Nutrition and Health Survey [4]. The increase in DM prevalence in the country through the years may be attributed to multiple factors, which include but are not limited to sedentary lifestyle, variety of food consumption, and even climate change .Effects of climate change, particularly how temperature affects human health, have been thoroughly studied with relatively similar patterns of increased risk in elderly and among patients with cardiovascular diseases in different cities and countries across the globe .Similar studies have been done in the Philippines, wherein greater risks were observed among the elderly, cardiovascular-related diseases, and women .In recent years, temperature effects on diabetes patients have been observed with increased susceptibility to both cold and hot temperatures .Heat impairs both the thermoregulative and orthostatic responses at high temperatures, while apparent loss of efferent vasomotor control during diabetic neuropathy have been noted in cold periods .However, most studies that explored the effects of temperature on diabetes mortality were mainly undertaken in temperate and subtropical cities .to the best of our knowledge, no study has been carried out in a tropical setting. This is the first study which explored the effects of temperature on diabetes mortality in a multi-city tropical setting. Furthermore, this study quantified the risks associated with extreme low, moderate low, moderate high and extreme high temperatures

Discussion: the study determined the risks associated with low and high temperatures on diabetes, with relatively higher risks in extreme high temperatures; evident in the pooled pattern. Particularly, we have observed that: (1) tropical cities have increased risks even at lower temperature, aside from the commonly observed high risk due to high temperature; and (2) that low temperature exhibits protective effects against diabetes. Although the individual risk curves have shown inconsistent patterns, we believe that the findings of this first multi-city tropical study can provide insights in developing strategies specific to the diabetes risk population in relation to the temperature percentiles, unique to tropical cities and countries.

There have been numerous studies which have explored the effects of temperature on mortality, and have recorded similar patterns across different cities among various countries .These patterns have been consistent not only in all-cause mortality, but also among specific mortality subgroups .In this study, we have observed that the effects of temperature on diabetes are higher in extreme temperatures as seen in , which are consistent with literature .The mechanism related to the increased risk in high temperatures among diabetics can be linked to the abnormalities of the thermoregulatory capacity caused by autonomic neuropathy .Autonomic neuropathy is a potentially lethal diabetic complication, which affects multiple organ systems and of different clinical manifestations, with severe consequences such as hypoglycemia unawareness and cardiovascular dysfunction. Furthermore, thermal stress intensifies the problems caused by autonomic neuropathy, by affecting the homeostasis, especially for cardiovascular and glycemia .The thermal burden affects insulin absorption and various counter-regulatory hormones, which can affect both acute and chronic glycemia.

On the other hand, we have observed greater risks in either the extreme or moderate low temperatures, particularly in Cebu City .At lag slice 7, in lag 0–15 as in, most of the cities have greater risks in both the extreme and moderate low temperature percentiles. These results are similar to the studies in China .The physiological mechanism of the increased risk of low temperatures on diabetes remains unclear. However, plausible associations can be linked towards too much exertion of the circulatory system leading to injured vasculature, which can be triggered by the extreme temperatures .Likewise, other studies have noted that the increased levels of hemoglobin can be observed in winter periods . HbA1c is associated with microvascular and macrovascular complications in diabetes .The increased HbA1c level poses inherent risks, which can be further amplified by the injured vasculature.

On the other hand, protective effects were present in both extreme and moderate low temperatures, particularly in Cebu City, at lags 0–15 and 0–21, as seen in The low temperature exposure may have therapeutic effect on diabetics, especially for

type 2 patients This therapeutic effect can be attributed to the improved the glycemic control through improvements in insulin sensitivity brought about by cold temperature [In order to prevent the decrease in the core body temperature, the body's normal physiological response is to increase the rate of metabolic heat production induced by shivering and non-shivering thermogenesis .This increase in metabolic energy production at low temperature further activates the brown adipose tissues, which oxidize triglycerides and glucose as fuel, thereby decreasing the glucose levels In a policy context, these results may prove to be useful in developing strategies focusing in the extreme temperature effects among diabetics, whereby, regardless of the lag in the city-specific risks, higher risks were observed in extreme temperatures. Diabetes patient care managers can use these results by managing accordingly the diabetic patients in relation to the temperature forecasts. For example, room temperature regulation can be endorsed during extreme temperature events. Similarly, there should be sufficient information dissemination of how both low and high temperatures affect diabetes patients even at a personal level management. Although this study has noted the protective effects of low temperature on diabetics, the causal pathway remains to be uncertain, whereby further research is warranted.

Conclusion: Previous knowledge from studies carried out in temperate and subtropical settings have noted the risks in high temperatures with some studies indicating inclined risks even in low temperatures. This is the first multi-city, tropical-setting study carried out to investigate the effects of temperature on diabetes mortality. Results of this study have noted that the: (1) risks for diabetics not only exist in high temperatures, but also in low temperatures in a tropical setting; and (2) low temperatures may have protective effect on diabetes. Policymakers and health managers should take into account low temperature periods for diabetes management to equip the risk population of the necessary information with the goal of averting the risk.

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