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INFLUENCE OF HEALTH ON THE WORK PERFORMANCE OF RASPBERRY PICKERS: A PILOT STUDY

Alejandra **García-Becerra**[1], María Guadalupe **Sánchez-Cervantes**[1], Nancy María **Aguilar-Hernández**[1], Silvia Rosario **Villa-Ramos**[1], José Abel **Chocoteco-Campos**[1*]

[1]Tecnológico Nacional de México. Instituto Tecnológico de Ciudad Guzmán. Avenida Tecnológico 100, Colonia Centro, Ciudad Guzmán, Jalisco, Mexico. C. P. 49000.
* Author for correspondence: jose.cc1@cdguzman.tecnm.mx

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ABSTRACT

Raspberry pickers are a specific group of agricultural workers whose labor conditions have received limited attention in research. Their working conditions, the health problems they face, and the factors affecting their performance remain scarcely explored. The aim of this pilot study was to analyze the relationship between farmworkers' self-perceived health status and their work performance, measured by the number of buckets harvested and the income derived from piece-rate work. Data were collected through a daily self-evaluation survey administered to a group of pickers over 53 harvest days. Workers' perceived health status was recorded at the beginning, during, and at the end of each workday, along with the number of buckets harvested per day. Simple correlation analysis yielded an r coefficient of 0.66, corresponding to a determination coefficient (R^2) of 0.44, indicating a moderate relationship between self-perceived health status and work performance. The results showed that poorer self-perceived health status was associated with a 21 % reduction in the number of buckets harvested relative to the group average. This reduction led to income differences of up to 35 % between the most and least productive pickers. These findings highlight the impact of health on both productivity and income among these workers. For future research, studies with larger samples and models incorporating additional factors are recommended to further clarify the relationship between health and productivity in this type of work.

Keywords: health condition, work performance, berry pickers, southern Jalisco.

INTRODUCTION

In 2023, Mexico's economically active population consisted of 60.8 million people (INEGI, 2023a), of which only 22.2 million were enrolled in the Mexican Institute of Social Security (IMSS). Within this group, at least 10 million people suffer from a chronic disease (IMSS, 2022). This situation places Mexico among the 10 countries with the greatest number of working-age people with chronic diseases, such as obesity and diabetes (Lin *et al*., 2020).

Since the beginning of this century, various studies have shown that workers' health affects their performance, particularly among those with chronic diseases (Grossman,

2000; Tompa, 2002; Berger *et al*., 2003; Mattke *et al*., 2007; Loeppke *et al*., 2009). Nevertheless, Munir *et al*. (2005) and Siu *et al*. (2013) suggest that workers with chronic diseases are not always less productive. In some cases, their performance can match or even surpass that of healthy workers due to self-management of the disease through the adaptation of coping routines and strategies.

Despite this evidence, there remains a significant gap in research on the health of agricultural day laborers, particularly in Mexico, where these workers face precarious conditions, low wages, and limited social protection (Barrón-Pérez, 2019; Flores-Mariscal, 2021; Aguilar-Cuevas and Colín-Martínez, 2022; Salgado-Viveros, 2023). Harvesting fruits and vegetables involves long working hours under demanding conditions, increasing health risks due to high temperatures and exposure to agrochemicals, as documented in studies conducted in Mexico (Palacios-Nava, 2003; Ortega-Martínez *et al*., 2019; Day *et al*., 2021) and in other countries (Cayir *et al*., 2019). In addition, little is known about berry pickers working in greenhouses, who perform their activities in enclosed spaces under high temperatures.

The number of agricultural day laborers in Mexico has increased significantly in recent years, especially in states such as Baja California, Sonora, Sinaloa, Jalisco, and Michoacán (Barrón-Pérez and Ortiz-Marín, 2022). Much of this growth has been driven by migrants from Oaxaca, Guerrero, Veracruz, and Chiapas seeking opportunities in the agricultural sector. It is estimated that more than 2 million day laborers work in the country's farmlands, of which 12.7 % of them are women. When their families are included, this population reaches approximately 8.5 million people (UN Women, 2022).

In Jalisco, the increase of day laborers is linked to the establishment of national and transnational agro-industrial companies in the southern region of the state, where climate and soil conditions are favorable for crops such as berries and avocado (Macías-Macías and Sevilla-García, 2022). According to the 2022 Agricultural Census, 189 324 agricultural production units were recorded in Jalisco, along with an agricultural surface of 2 127 242 ha. These figures reflect the importance of the sector in the state, which has shown a tendency toward technification through systems such as protected agriculture (INEGI, 2023b). This trend is particularly evident in Zapotlán El Grande, where the marked increase in enclosed greenhouses between 2007 and 2022 illustrates agricultural expansion and modernization.

Despite economic development in the region (Lagunes-Fortiz *et al*., 2020; Cruz-López *et al*., 2022; Macías-Macías and Sevilla-García, 2022), working conditions for agricultural laborers, particularly those harvesting berries in enclosed greenhouses, are characterized by exposure to high temperatures, increasing the risk of heat stroke, dehydration, and other health issues. This is compounded by exposure to agrochemicals, whose effects may be intensified under high-temperature conditions, further increasing health risks.

Previous studies have identified risk factors in the working conditions of Mexican day laborers, including exposure to toxic chemical products (Palacios-Nava,

2003; Haro-Encinas, 2007; Ortega-Martínez *et al*., 2019; Alvarado-Ibarra *et al*., 2019; Sánchez-Gervacio *et al*., 2020) and limited access to medical services (Aranda and Castro-Vázquez, 2016; Escobar-Latapí *et al*., 2019; Arellano-Gálvez *et al*., 2023). These conditions increase worker vulnerability, as they often must cover their own medical expenses due to the lack of employment benefits that include specialized care.

The relationship between health and productivity among agricultural workers has received limited attention in the scientific literature. Some studies have examined how high temperatures affect the physical health of day laborers working outdoors and their impact on productivity (Sahu *et al*., 2013; Amini *et al*., 2021; Castillo *et al*., 2021; Pan *et al*., 2021). However, no specific studies have been identified, either in Mexico or internationally, focusing on berry pickers working in greenhouses.

This study seeks to document the self-perceived health status of a group of raspberry pickers during their workday and to analyze how it influences their performance and income. The hypothesis is that, in raspberry harvesting under protected agriculture in southern Jalisco, workers who report a poorer self-perception of their health status show, on average, lower work performance compared to those with better perceived health conditions.

MATERIALS AND METHODS

The study was conducted in an agro-industrial company dedicated to raspberry (*Rubus idaeus* L.) production under protected agriculture, located in the town of Usmajac, municipality of Sayula, in the southern region of Jalisco, Mexico, during the first harvest season of the year, between March and May 2024. The area is characterized by a growing concentration of greenhouses and a high demand for day-laborer workforce. The work dynamic is based on daily harvesting shifts under a piece-rate payment scheme, in which workers' income depends directly on the harvested volume. Participants were seasonal agricultural laborers with limited access to social security services, a situation commonly observed in this type of production system.

The selected greenhouses consisted of roofed polyethylene macro-tunnels. At the time of the study, the plants were two years old and produced fruit continuously throughout the 53-day harvesting period. A non-probabilistic convenience sampling approach was used, selecting a crew of 10 raspberry pickers (five men and five women), aged 25 to 49 years, with varying levels of experience with the crop. Monitoring initially began with a larger group; however, due to the high turnover typical of temporary agricultural employment, only 10 individuals completed the 53 consecutive days of records. This sample represents 25 % of the total workforce (40 workers) in the greenhouse, which is adequate for a longitudinal exploratory study.

Given the nature of the design, priority was given to the depth of temporal monitoring rather than sample size. Continuous recording over 53 days allowed the generation of a database of 530 observations, constituting a robust time series per individual. This approach minimizes bias from isolated measurements and enables observation of

performance variability in relation to fluctuations in health conditions, providing the statistical rigor required for correlation analysis at a microergonomic level.

Participants worked from Monday to Saturday in shifts from 07:30 to 16:00, with the possibility of overtime depending on demand. The relevance of analyzing this group lies in the regional context of Usmajac and southern Jalisco, which concentrates one of the highest densities of economic units dedicated to greenhouse red fruit production. This sector represents a key source of employment that requires specific studies on worker health and productivity (INEGI, 2024).

A simple correlation model was used to evaluate the relationship between health condition, measured through perceptual self-evaluation, and worker performance. The analysis was based on Pearson's correlation coefficient (r), with perceived health condition as the independent variable and daily productivity, measured by the number of buckets harvested, as the dependent variable, which may be influenced by factors such as the piece-rate payment scheme and worker experience.

At the beginning of the study, sociodemographic information was collected through individual, face-to-face interviews, recording variables such as sex, age, and years of experience in berry harvesting. Additionally, a section was included to identify chronic diseases or specific physical and mental health conditions (Table 1). Information on diseases was obtained from workers' self-reports.

It is recognized that some participants may not know the formal diagnosis of their health condition or may be unaware of undiagnosed conditions due to limited access to healthcare services. For this reason, the analysis is based on perceived health status rather than clinical diagnoses. It is important to note that, due to the commitment to anonymity, the high labor mobility in the sector, and the need to avoid any perception of harassment toward workers, only self-perception scales and self-reports were used instead of official clinical or institutional medical records.

A self-evaluation questionnaire was designed to measure perceived health status at the beginning, during, and at the end of each shift, using a numerical scale from 1 to

Table 1. Sociodemographic and self-reported health conditions questionnaire administered during personal interviews.

Worker number: _____ Sex: M F Age: _____ Experience (in years): _____

Please indicate the diseases you have:

Allergies	High cholesterol	Glaucoma	Thyroid problems
Anemia	Colitis	Hypertension	Cysts in ovaries
Anxiety	Convulsions	Incontinence	Migraine
Arthritis	Diabetes	Insomnia	Prostate disorder
Asthma	Depression	Kidney failure	Skin disorder
Bronchitis	Emphysema	Obesity	Mammary disorder
Cancer	Endometriosis	Hearing loss	Psychological disorder
Cataracts	Fibromyalgia	Kidney stones	Ulcers/reflux
Blood clots	Gastritis	Heart problems	Other(s): _____

10 (1 = worst condition, 10 = best condition) (Table 2). Each day, workers recorded the total number of buckets harvested on a form pre-filled with their identification number and the date. A short questionnaire format was selected to minimize disruption to participants' daily activities. The use of a longer instrument, such as those applied in the National Health and Nutrition Survey (ENSANUT), would have been impractical for daily use, as it could have reduced engagement and affected response quality. Physical exhaustion accumulated at the end of the workday may influence perceived health status, making it difficult to distinguish between the effects of pre-existing conditions and fatigue derived from the work shift. This aspect is considered an inherent limitation of the study design.

Table 2. Daily self-assessment form for perceived health status and productivity in raspberry pickers.

Worker:		Date:									
On a scale of 1 to 10, 1 being the worst and 10 being the best, mark your answer with an "x" in each section.											
Question	Moment	1	2	3	4	5	6	7	8	9	10
How would you rate your health condition in the three moments of your shift?	At the start During the shift At the end										
How many buckets did you harvest today?											

The study was conducted in accordance with ethical research principles, ensuring that all participants provided informed consent. The confidentiality of the information was protected through the use of anonymous identifiers and secure data handling. In addition, workers received a simple explanation of the study's purpose and of the concept of health status in terms they could easily understand, ensuring clarity in their responses: "When we speak of health status or health condition, we mean how you feel physically and mentally to do your work, whether you have energy, if you feel well, or if something is bothering you, such as a headache, fatigue, or discomfort. We want to know if, when you start, continue, or finish your shift, you notice any difference in how your body feels and how that may affect the number of buckets you are able to harvest."

This approach promoted active and honest participation without requiring technical knowledge of health. The administration and supervision of the questionnaire were carried out by one of the authors during her professional residency in the greenhouse, which made it possible to build trust with participants, address questions immediately, and ensure consistency in data collection. The questionnaire was administered daily over a period of 53 harvest days, exclusively on days when the full crew was present

and reported no symptoms of acute illness, such as flu, diarrhea, or physical injuries. Days with such incidents were recorded and excluded from the statistical analysis.

Workers' shifts began at 07:30, when they collected their equipment, consisting of buckets and belts. At 08:00, they entered the assigned tunnels to begin harvesting, maintaining the same assignments throughout the season. At 10:00, they paused for breakfast and then continued working until 16:00, when they finished their shift and returned their equipment to the packing area. The number of buckets harvested each day was recorded and verified at the end of the workday, as workers' income depended directly on the number of buckets delivered. Although regular working hours were from 07:30 to 16:00, shifts often extended depending on production demand, with the option of overtime. This study considered only the buckets harvested during regular hours.

The daily thermal progression in Usmajac emerged as a determining environmental factor in this study. Weather conditions reached levels classified as "very hot" after 14:00 (Figure 1), which, together with the microclimate generated by polyethylene macro-tunnels, represented a physiological challenge for berry pickers. This temperature increase and the accumulation of thermal stress not only reduce the metabolic efficiency required to maintain piece-rate work but may also influence the self-perception of health status.

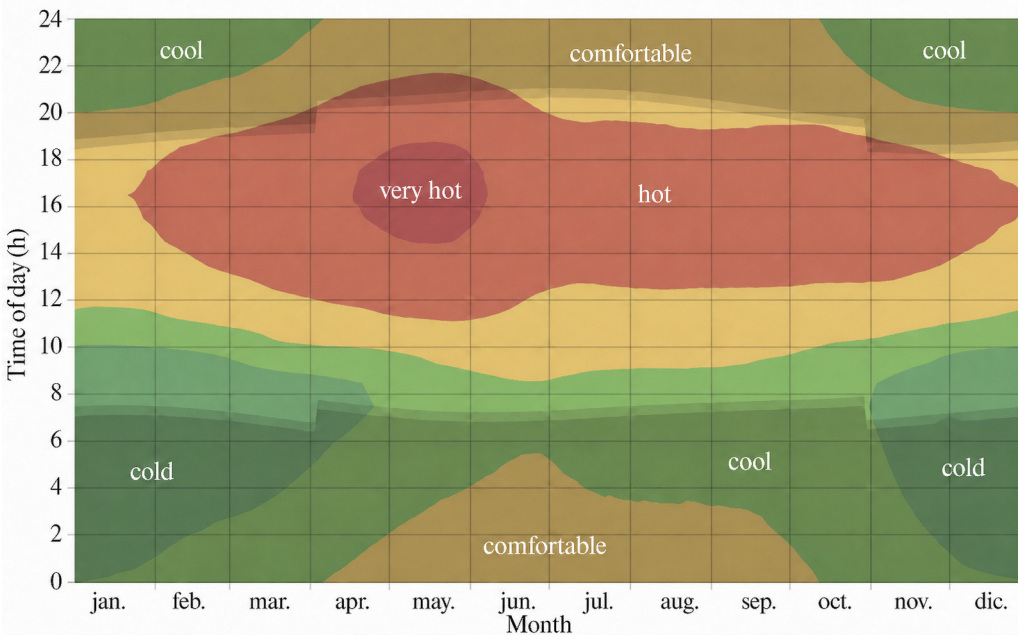

Figure 1. Average annual temperature per hour in Usmajac, in the south of the state of Jalisco, Mexico (Weather Spark, 2026).

In this context, it is likely that symptoms reported by workers, such as migraine and irritable bowel syndrome (IBS), are aggravated by mild dehydration or thermal fatigue resulting from prolonged heat exposure. Work performance in the berry sector is therefore not an isolated variable, but the outcome of a complex interaction between workers' chronic health conditions and the extreme microclimatic conditions of the agricultural environment.

The study design made it possible to capture workers' daily health status without interfering with their activities, which were carried out under continuous workday conditions, with only one break for eating and hydration. This break occurred individually and voluntarily during the course of the work, without structured interruptions, ensuring that evaluations remained consistent throughout the 53-day period.

RESULTS AND DISCUSSION

The personal information of the participating workers (Table 3) reflects that the majority has at least one chronic disease, with an average of 1.7 diseases per person. The most common conditions were migraine, overweight, diabetes, colitis, hypertension, and anxiety. Overweight, diabetes, and hypertension are consistent with the most common conditions confirmed in Mexican workers (IMSS, 2022).

Table 3. Sociodemographic profile, work experience, and self-reported health conditions of participating workers.

Worker	Sex	Age (years)	Experience (years)	Diseases suffered
T1	F	32	12	Anxiety, diabetes, and overweight
T2	M	39	5	Diabetes and hypertension
T3	F	44	12	Depression
T4	F	49	10	Migraine
T5	M	34	8	Irritable bowel syndrome and overweight
T6	M	45	25	Hypertension and migraine
T7	F	26	3	Migraine
T8	M	25	5	Bronchitis
T9	F	27	6	Anxiety, colitis, and overweight
T10	M	27	5	None

The average perceived health status reported by workers was calculated for each moment of the shift over the 53 days of the study (Figure 2). This metric reflects the variability of perceptions recorded at three key moments of the work shift: at the beginning (08:00–10:00), during the shift (10:00–14:00), and at the end (14:00–16:00). This dispersion analysis is crucial for assessing the consistency of individual reports

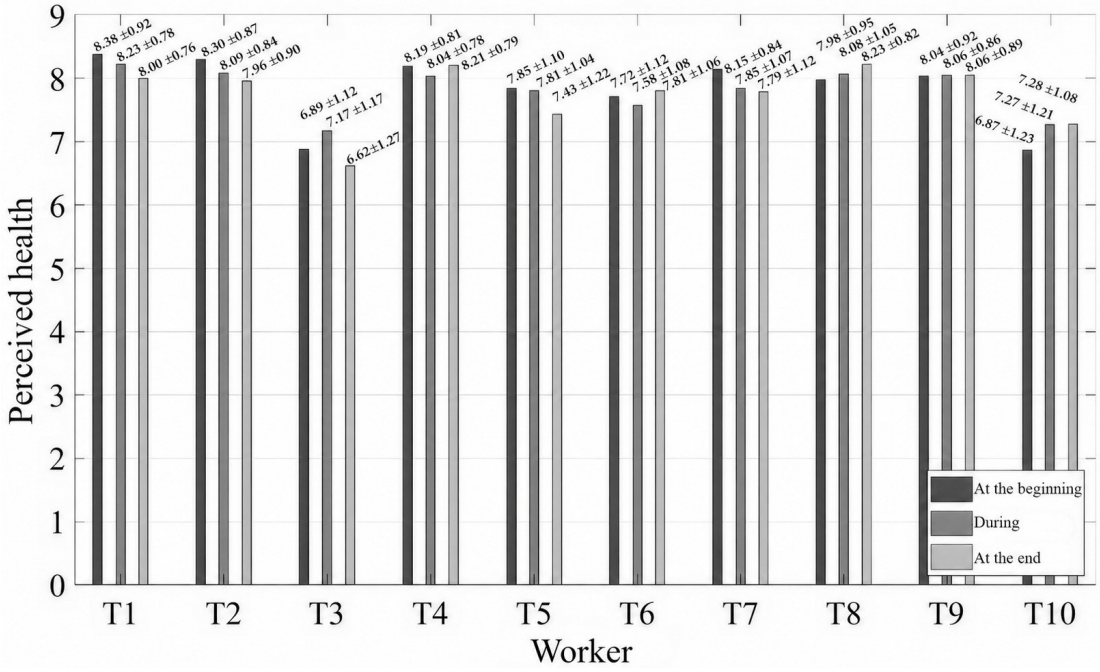

Figure 2. Average perceived health status, reported by workers on a scale of 1 to 10, during three periods of the shift. This data is calculated from the average over the 53 days of the study, which took place during a shift from 08:00 to 16:00.

in relation to environmental conditions and changing thermal stress throughout the sampling period. Half of the workers rated their health status slightly above level 8 (on a 1–10 scale).

Variability between moments of the day was minimal (below 0.5); however, variability between workers was evident, particularly in T3 and T10, who reported averages around 7.0. Worker T3 reported depression. Workers T1, T2, T3, T5, and T7 reported a slight decline in health status as the day progressed. This reduction may be related to fatigue and increasing greenhouse temperatures, effects supported by previous studies under field conditions (Sahu *et al*., 2013; Amini *et al*., 2021; Castillo *et al*., 2021; Pan *et al*., 2021). The health status of two workers (T4 and T9) remained stable, while in three workers (T6, T8, and T10) it improved during the shift. All workers whose health remained unchanged or declined reported at least one chronic condition, in contrast to T10, whose health improved and who reported no disease.

Regarding productivity (Figure 3), the average number of buckets harvested per worker was calculated over the 53 days of monitoring. A general variability of 40.04 buckets was recorded in daily performance, allowing quantification of fluctuations in individual output and operational consistency under work demands. Despite their health conditions, workers T1, T4, T8, and T9 harvested the highest number

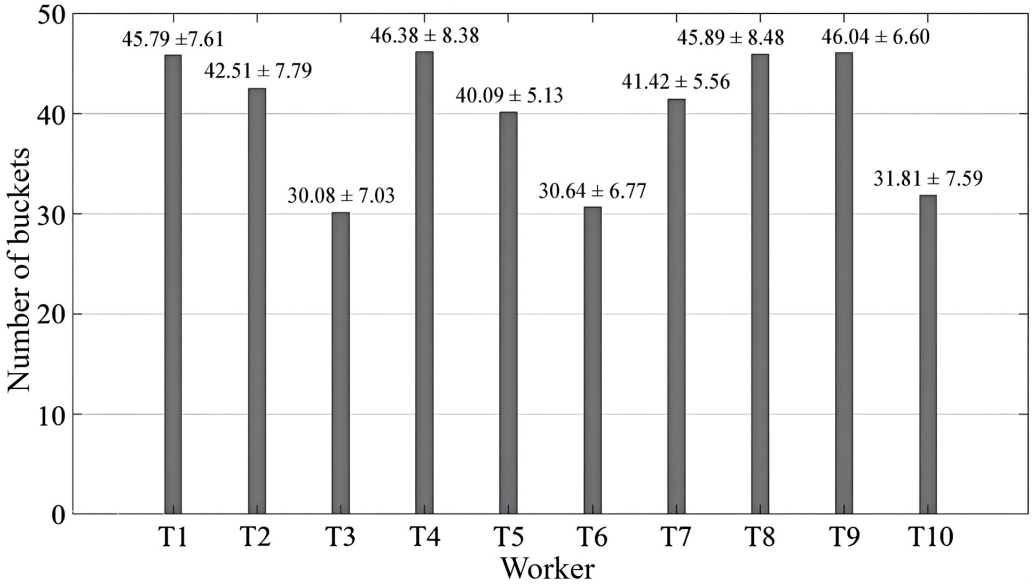

Figure 3. Average daily productivity, measured as the number of buckets harvested per worker during the 53 days of monitoring.

of buckets. T1 and T9, both women, reported three chronic conditions each. This supports observations by Munir *et al*. (2005) and Siu *et al*. (2013), suggesting that workers with health conditions can be as productive as, or more productive than, the average, highlighting the role of self-management. However, the higher performance observed among female workers may also reflect sex-related differences, which were not independently analyzed in this study.

In contrast, workers T3, T6, and T10 harvested fewer buckets than average. T3 and T6 were the oldest and most experienced workers, both reporting at least one chronic condition. T10, one of the youngest (27 years old), had relatively low experience (5 years) and reported no chronic disease. This disparity should not be attributed to attitudinal factors; rather, it suggests the influence of unmeasured variables, such as limited technical dexterity due to experience level or strategies for self-regulation of physical effort under prevailing environmental conditions. This highlights the importance of considering physiological factors and technical expertise before drawing conclusions about individual performance.

The relationship between self-perceived health status and the number of buckets harvested (Figure 4) yielded a correlation coefficient (r) of 0.66, indicating a moderate positive association between the variables. In general, workers reporting better health tended to harvest more buckets. Workers T3 and T4 represented contrasting cases of performance. Both were women of similar age and experience in berry harvesting. Worker T3, with an average of 30.08 buckets, showed lower productivity, whereas

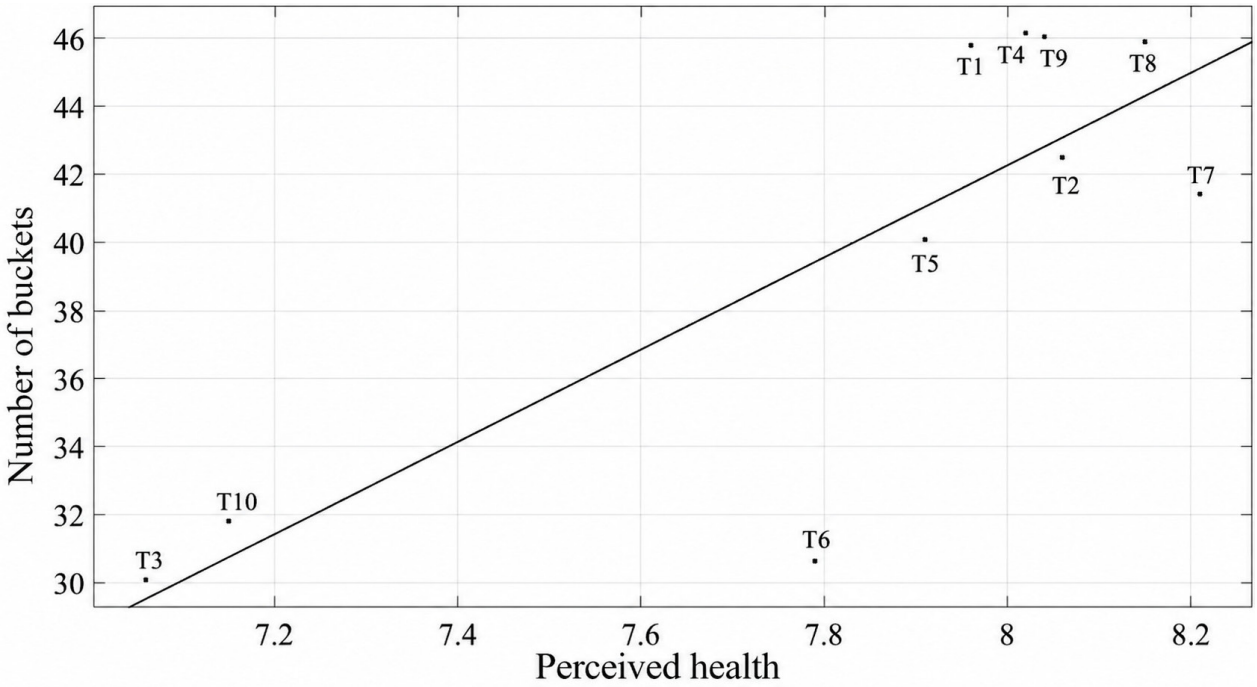

Figure 4. Correlation between the health condition of the workers and the buckets gathered during their workday.

T4 achieved higher performance with an average of 46.15 buckets. This contrast highlights the influence of the type of condition (depression in T3 versus migraine in T4) and health status (7.15 vs. 8.02) on productivity.

The visual comparison of individual harvesting performance during the study period (Figure 5) shows a clear difference between the seven most productive and the three least productive workers. This performance gap reflects the influence of physical well-being on productivity, particularly in physically demanding activities such as raspberry harvesting. The reduction in the number of buckets harvested over time is explained by the nature of the crop, as raspberries are harvested daily (except Sundays), leading to a gradual decrease in available fruit as the season progresses. During the study period, each bucket harvested in a regular shift was paid at MXN 18. Worker T3 earned a total of MXN 28 696.6, while T4 earned MXN 44 027.1, representing a difference of 34.82 %, excluding additional company benefits. Compared to the average, wage reductions for T3, T6, and T10 ranged from 20 % to 22 %, exceeding the 4–6 % reported by Castillo *et al*. (2021) for fruit pickers and the 5–10 % estimated by Levasseur (2019) for workers in other piece-rate sectors.

In terms of age and years of experience in berry harvesting (Figure 6), no significant relationship was found with the number of buckets harvested. The highest correlation value obtained (r = 0.23) confirms that age and experience did not have a relevant influence on productivity in this context.

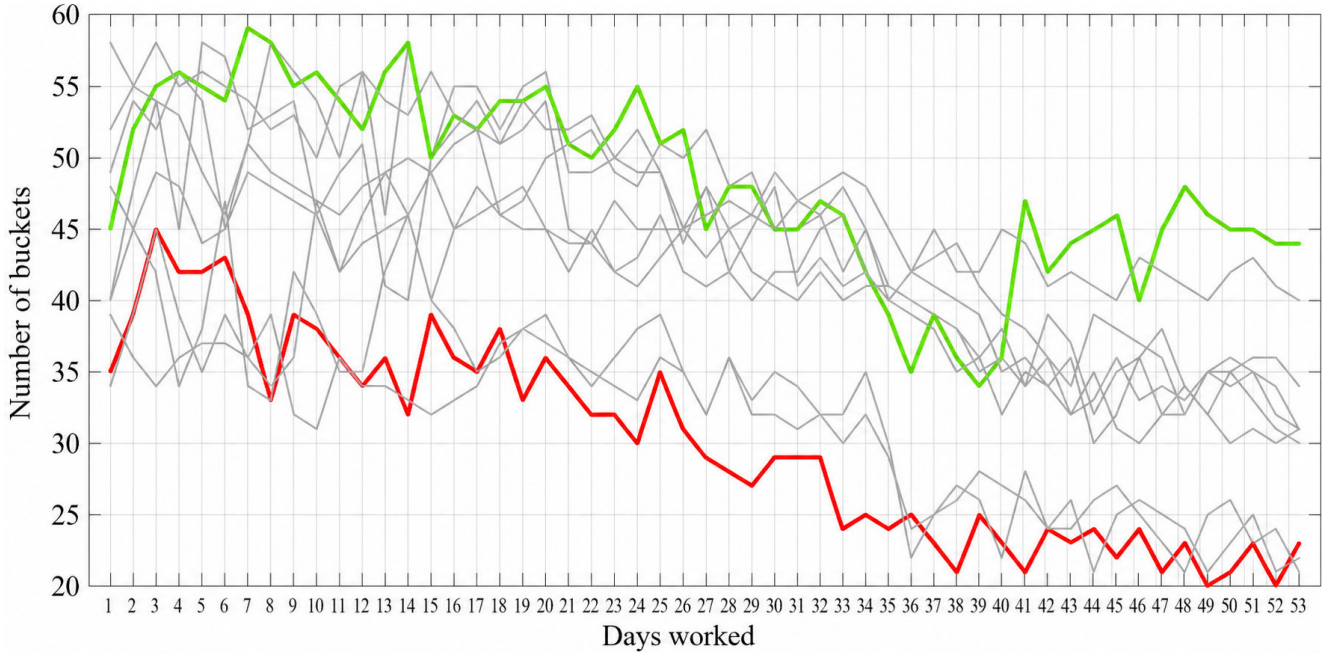

Figure 5. Daily number of buckets picked per worker during the study period. The harvest of worker T3 is highlighted in red (lowest performance) and in green, the harvest of worker T4 (highest performance).

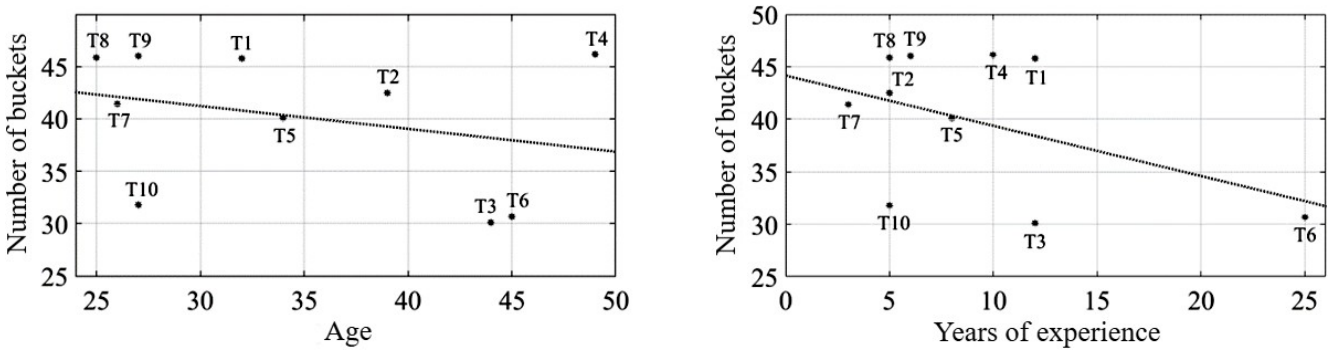

Figure 6. Relationship between worker age, years of experience, and number of buckets harvested.

This study recognizes that the relationship between self-perceived health status and the work performance of agricultural workers does not occur in isolation, but is influenced by a combination of factors. Internal factors include emotional state and coping strategies, while external factors encompass productivity demands and exposure to environmental risks, such as high temperatures inside macrotunnels. The results are consistent with previous studies documenting significant reductions

in productivity under adverse health conditions (Adhvaryu *et al*., 2020; Cole and Neumayer, 2006), as well as with studies reporting losses of similar magnitude (18 to 30 %) associated with thermal stress (Ferro *et al*., 2025; Sheng *et al*., 2025).

Under this premise, and considering the multicausal nature of the phenomenon, the current design is recognized as capable of incorporating a greater number of intervening variables. Factors such as fruit biological density, accumulated worker experience, and precise microclimatic variation mediate the observed relationship. Nevertheless, as an exploratory phase, the results establish the relevance of these dimensions in a high-demand context such as Usmajac and southern Jalisco, where one of the highest densities of economic units dedicated to greenhouse berry production is concentrated (INEGI, 2024). This aligns with Parsons *et al*. (2022), who suggest that thermal impact is a multivariate challenge linking activity intensity with individual responses. In this sense, the findings from Usmajac contribute to refining Exposure-Response Functions (ERF), establishing a basis for disaggregating the economic impact in agricultural sectors of middle latitudes.

CONCLUSIONS

This preliminary study shows that agricultural workers engaged in greenhouse berry harvesting present a high prevalence of chronic diseases, with 9 out of 10 participants reporting at least one condition. The relationship between self-perceived health status and job performance indicates that poorer health reduces work output and, consequently, workers' wages by 21 % compared to the crew average. Some workers maintained high productivity levels despite having chronic conditions, suggesting that self-management of health may mitigate certain negative effects on performance. Although the results show a significant correlation between self-perceived health status and work performance ($r = 0.66$), it is essential to recognize that agricultural productivity is a multicausal phenomenon. In this initial sample, a spectrum of conditions was identified, ranging from chronic metabolic diseases (diabetes, hypertension, and overweight) to socio-emotional and psychosomatic disorders (anxiety, depression, and irritable bowel syndrome). This diversity indicates that health affects not only physical capacity but also cognitive and emotional well-being, both of which are critical in piece-rate work systems.

This study provides a basis for a subsequent multivariate design integrating mental health dimensions, agronomic factors, and extreme weather conditions. Future research with larger samples ($N > 50$) will aim to quantify the contribution of each health dimension and incorporate the Wet Bulb Globe Temperature Index (WBGT) to adjust results according to actual heat load. This approach will enable a more comprehensive and precise understanding of the relationship between health and productivity in technified agricultural environments.

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