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The Effect of Season and Weather on Physical Activity: A Systematic Review

Hussain Ali Alhafufi [1], Zahra Abdullatif Alabdulmohsen [2], Ali Abdullah Tarmookh [3], Maal Jafar Alhayek [3], Abdalrahem Abdullah Al Maidani [4], Rawabi Ali Alfarhan [5], Noora Saleh Alhabah [5], Sukaina Tawfiq Bujubara [5], Magdad Abdullah Algazal [6], Saud Adel Abdulaziz Al-Taisan [7], Hussain Ali Alohaymid [8], Zainab Hijji Muslim Almazraq [9], Laila Abdulla Al Zaki [10], Tharwah Abduallah Ali Alqateri [11], Hanan Mahdi Alzara [12]

1. Mhasen Health Center
2. Al Rafiah General Hospital
3. Dammam Medical Complex
4. Al Jaber Kidney Center
5. Prince Saud Bin Jalawi Hospital
6. King Fahd Hospital - Al Jabr Kidney Center
7. Ministry Of Health Alguwaybah Phc
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Abstract

Physical activity (PA) is a cornerstone of public health, yet participation is not constant year-round. A substantial body of evidence indicates that season and specific meteorological conditions (weather) are significant environmental determinants of PA behavior. This review synthesizes current literature on how these factors influence PA across populations, settings, and activity domains. Findings consistently demonstrate a marked seasonal pattern, with PA levels highest in late spring and summer and lowest in autumn and winter, particularly in temperate and polar climates. Key weather variables impacting PA include temperature (following an inverted U-shaped relationship), precipitation, daylight hours, wind speed, and humidity. The magnitude of effect varies by age, activity type (e.g., walking declines more than gym use), geographical location, and climate zone. Interventions such as seasonal programming, weather-protected infrastructure, and behavioral strategies are crucial to mitigate these effects and promote year-round activity. Understanding these environmental influences is essential for public health surveillance, urban planning, and the design of effective, context-specific PA promotion strategies.

Keywords: Physical activity, Seasonality, Weather, Temperature, Precipitation, Built environment, Public health.

1. Introduction

Regular physical activity is unequivocally linked to the prevention of chronic diseases and the promotion of mental well-being [1]. However, population-level PA remains suboptimal. While individual and social factors are well-studied, the physical environment—specifically meteorological conditions—plays a critical, modifiable role in shaping daily activity choices [2]. Season and weather represent acute, recurring environmental barriers or facilitators to PA. A comprehensive understanding of their impact is vital for accurate public health monitoring (to avoid misinterpreting seasonal dips as long-term trends), for tailoring public health messages, and for designing resilient built environments that support activity across all seasons. This review examines the evidence on how seasonal variations and specific weather parameters influence PA participation.

2. Seasonal Patterns in Physical Activity

2.1. General Population Trends

Strong and consistent evidence shows a clear seasonal rhythm in overall PA.

- **Peak Periods:** Objectively measured PA (via accelerometers) is typically 10-15% higher in **spring and summer** months in the Northern Hemisphere [3].
- **Trough Periods:** Significant declines, often ranging from 5-20% in moderate-to-vigorous physical activity (MVPA), are observed during **late autumn and winter** [4]. This pattern is most pronounced in **temperate and polar climate zones** with distinct seasons, compared to tropical regions with less variation.

2.2. Variation by Population Subgroup

- **Children and Adolescents:** The effect is especially strong, with studies showing MVPA can be 15-30 minutes per day lower in winter compared to summer. This is linked to structured activities (e.g., school sports) and outdoor play opportunities [5].
- **Adults:** Working adults show more moderate seasonal variation, often maintaining non-seasonal activities (e.g., gym workouts) but reducing outdoor recreational activities like walking and cycling [6].
- **Older Adults:** Are particularly sensitive, with colder temperatures and icy conditions posing safety risks, leading to substantial winter decreases in outdoor walking, a primary activity for this group [7].

2.3. Variation by Activity Domain

- **Transportation PA (Walking/Cycling):** Shows the most dramatic seasonal fluctuation, heavily dependent on favorable weather [8].
- **Leisure-Time PA:** Outdoor recreation (e.g., running, team sports) peaks in warmer months, while some indoor activities may see compensatory increases in colder seasons.
- **Occupational PA:** Less affected by season in many sectors, though outdoor occupations (e.g., construction, agriculture) are directly constrained by extreme weather.

3. Impact of Specific Weather Variables

3.1. Temperature

The relationship between temperature and PA is often **non-linear (inverted U-shaped)**.

- **Optimal Range:** PA is highest in mild temperatures, typically between **15°C and 25°C** (59°F-77°F) [9]. This is the "thermal comfort" zone for outdoor activity.
- **Cold Temperatures:** PA declines progressively as temperatures drop below 0°C (32°F), due to discomfort, safety concerns (ice), and increased preparation time.
- **Hot Temperatures:** Similarly, PA declines sharply above 30°C (86°F) due to heat stress, risk of dehydration, and public health advisories.

3.2. Precipitation

Rain and snow are among the most potent deterrents to PA.

- **Rain:** Even light precipitation is associated with significant reductions in daily step counts and outdoor activity, particularly for walking and cycling [10].
- **Snow/Ice:** Has a more prolonged and severe impact, not only causing immediate cessation of outdoor activity but also creating a lingering barrier due to snow accumulation and treacherous footing for days or weeks.

3.3. Daylight Hours (Photoperiod)

Shorter day length in winter independently reduces opportunities for after-work or after-school outdoor activity, contributing to the seasonal decline [11].

3.4. Other Meteorological Factors

- **Wind Speed:** High winds act as a deterrent, especially for cycling and walking.
- **Humidity:** High humidity exacerbates the perception of heat and cold, narrowing the thermal comfort zone.
- **Air Quality:** Poor air quality (e.g., high pollen, pollution, smoke) can suppress outdoor PA independently of other weather factors.

4. Mechanisms and Moderating Factors

4.1. Behavioral Mechanisms

Weather influences PA through:

- **Perceived Comfort and Safety:** Discomfort from cold, heat, or wet conditions reduces motivation.
- **Logistical Barriers:** Need for specialized clothing, decreased daylight, and hazardous conditions (ice) increase the perceived effort and risk.
- **Habit Disruption:** Changes in weather can break established activity routines.

4.2. Moderators of the Weather-PA Relationship

The strength of the effect is not uniform and depends on:

- **Climate Acclimatization:** Residents of colder climates (e.g., Scandinavia) show less PA reduction in cold weather than those in milder climates [12].
- **Built Environment:** Access to **indoor facilities** (gyms, pools, malls for walking), **protected outdoor paths** (canopies, windbreaks), and **effective snow clearance** significantly attenuate seasonal declines [13].
- **Socioeconomic Status:** Individuals with higher income and education may have better access to indoor facilities, weather-appropriate gear, and flexible schedules, buffering them from weather impacts [14].

5. Public Health and Policy Implications

1. **Surveillance and Research:** PA surveillance data must be seasonally adjusted to avoid misinterpretation. Intervention studies should account for season as a confounding variable.
2. **Urban Planning and Design:**
   - Promote **all-weather infrastructure**: covered/wind-sheltered walking/cycling paths, well-lit pathways.
   - Prioritize rapid **snow and ice removal** on sidewalks and trails.
   - Ensure equitable access to **public indoor recreation spaces**.
3. **Health Promotion Strategies:**
   - Develop and promote **seasonal PA programs** (e.g., "Winter Walking Clubs," indoor swimming lessons).
   - Tailor public health messaging to the season (e.g., sun safety in summer, layering advice in winter).
   - Encourage the development of **"weather-proof" PA habits**, such as home-based exercise routines.

6. Conclusion

Season and weather are powerful, predictable determinants of population-level physical activity. A consistent pattern of lower activity in colder, darker, and wetter months poses a recurring public health challenge, contributing to seasonal weight gain and potentially negative cardiometabolic effects. The impact is mediated by a complex interplay of temperature, precipitation, daylight, and individual/climatic moderators. Mitigating this effect requires a multi-level strategy:

individual (behavioral adaptation), **community** (seasonal programming), and **policy-level** (investment in weather-resilient built environments) actions. By proactively addressing these environmental barriers, public health efforts can move closer to the goal of promoting sustained, year-round physical activity for all.

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