

Correlación entre los perfiles de fuerza, patrones de compensación y composición corporal con la funcionalidad de la rodilla en corredoras recreativas de la ciudad de Barranquilla

Nombres y apellidos

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RESUMEN

El presente estudio aborda la relación entre tres componentes fundamentales de la biomecánica del movimiento, el perfil de fuerza del tren inferior, los patrones de compensación y la composición corporal con la funcionalidad de la rodilla en corredoras recreativas de la ciudad de Barranquilla. En un contexto donde el running femenino ha crecido de manera acelerada y las lesiones de rodilla se mantienen como una de las causas más frecuentes de dolor y limitación, comprender cómo estos factores interactúan resulta esencial para optimizar el rendimiento y prevenir disfunciones.

Para este propósito participaron 74 mujeres entre 18 y 65 años, todas con experiencia regular en la práctica del running. Las evaluaciones se realizaron mediante el protocolo Countermovement Jump (CMJ) utilizando el sistema de análisis de movimiento BTS Smart-DX, que permitió obtener mediciones precisas sobre la fuerza, el comportamiento cinemático y la existencia de asimetrías entre extremidades. Paralelamente, la composición corporal fue medida con el equipo InBody, mientras que la funcionalidad de la rodilla se evaluó con la Escala de Kujala, ampliamente utilizada para valorar síntomas y limitaciones asociados a trastornos de rodilla.

Los datos sociodemográficos mostraron un grupo conformado en su mayoría por mujeres adultas jóvenes, con un índice de masa corporal dentro de los rangos saludables. A pesar de esto, más de la mitad reportó la presencia de dolor durante la carrera. Esta discordancia entre la buena condición física general y la presencia de dolor subraya la importancia de analizar no solo la fuerza global, sino cómo se distribuye y coordina esa fuerza durante el movimiento.

Uno de los hallazgos más relevantes fue la asociación positiva entre la fuerza relativa, es decir, fuerza ajustada al peso corporal y la funcionalidad de la rodilla. Las corredoras con mayor fuerza relativa alcanzaron mejores puntuaciones en la Escala de Kujala, lo que sugiere que la estabilidad articular depende más de la eficiencia con la que se genera fuerza que de la magnitud absoluta de la misma. Este hallazgo coincide con literatura previa que plantea que la eficiencia mecánica, más que la fuerza bruta, es determinante para amortiguar cargas y prevenir el deterioro estructural.

Sin embargo, al comparar directamente a corredoras con alta y baja funcionalidad, no se observaron diferencias estadísticamente significativas en las medidas absolutas de fuerza o potencia. Esto indicó que la funcionalidad no depende únicamente del desempeño muscular, sino también de factores como los desbalances funcionales, la composición corporal y los patrones compensatorios adquiridos durante la carrera.

Los análisis multivariados revelaron dos predictores determinantes de la disminución funcional: la masa grasa corporal y la asimetría de fuerza concéntrica. Un mayor porcentaje de grasa corporal se asoció con peor desempeño funcional, probablemente por el incremento de la carga mecánica sobre la rodilla y por la influencia metabólica del tejido adiposo, que puede exacerbar procesos inflamatorios y sensibilidad al dolor. La asimetría de fuerza concéntrica, por su parte, emergió como el predictor más sólido tanto de menor funcionalidad como de mayor probabilidad de dolor, evidenciando que los desbalances entre ambas

extremidades funcionan como un factor crítico en la mecánica de carrera y en la salud articular. Asimismo, la edad mostró asociación con una mayor probabilidad de dolor, lo que podría reflejar la acumulación de carga mecánica y microadaptaciones del movimiento a lo largo del tiempo. Sin embargo, variables como la potencia pico y la masa muscular no demostraron ser predictores significativos de funcionalidad cuando se evaluaron de manera conjunta con otros factores.

En conjunto, este estudio ofrece una visión integral de las correlaciones biomecánicas que influyen en la funcionalidad de la rodilla en corredoras recreativas. Los hallazgos resaltan la importancia de intervenciones personalizadas orientadas a corregir asimetrías de fuerza, optimizar la composición corporal y promover estrategias de entrenamiento que fortalezcan el tren inferior de manera simétrica. Más allá de presentar datos, este estudio busca aportar herramientas que permitan que las mujeres que han adoptado el running como estilo de vida puedan hacerlo con mayor seguridad, salud articular y continuidad en la práctica.

Palabras clave: Corredoras recreativas, fuerza muscular, composición corporal, patrones de compensación, funcionalidad de rodilla, asimetría de fuerza.

ABSTRACT

This study examines the relationship among three fundamental biomechanical components: lower-limb strength profile, compensation patterns, and body composition and their influence on knee functionality in recreational female runners from the city of Barranquilla. As women's participation in running continues to rise and knee injuries remain one of the most common causes of pain and functional limitation, understanding how these factors interact is key to improving performance and preventing dysfunction.

Seventy-four women aged 18 to 65, all with consistent running experience, took part in the study. Evaluations were performed using the Countermovement Jump (CMJ) protocol with a BTS Smart-DX motion analysis system, which enabled highly accurate measurements of force production, kinematic behavior, and asymmetries between limbs. Body composition was assessed through InBody bioimpedance, while knee functionality was measured using the Kujala Anterior Knee Pain Scale, a widely validated tool for assessing symptoms and limitations associated with patellofemoral disorders.

Sociodemographic data revealed a sample largely composed of young adult women with body mass index values within healthy ranges. Despite this, more than half reported pain during running. This discrepancy between apparently good physical condition and the presence of pain highlights the importance of analyzing not only overall strength but also how that strength is coordinated and distributed during movement.

One of the most significant findings was the positive association between relative strength, force normalized to body weight and knee functionality. Runners with greater relative strength scored higher on the Kujala Scale, suggesting that joint stability depends more on the efficiency of force generation than on absolute force alone. This supports previous research indicating that mechanical efficiency, rather than raw strength, plays a key role in shock absorption and structural protection during repetitive activities like running.

However, direct comparisons between runners with high and low functionality did not reveal statistically significant differences in absolute strength or power. This indicates that functionality is not determined solely by muscular performance, but also by factors such as functional imbalances, body composition, and compensatory patterns developed during running.

Multivariate analyses identified two variables as strong predictors of reduced knee functionality: body fat mass and concentric strength asymmetry. Higher fat mass was associated with poorer functionality, likely due to increased mechanical loading on the knee and metabolic effects of adipose tissue, which may heighten inflammation and pain sensitivity. Concentric strength asymmetry emerged as the most robust predictor of both decreased functionality and greater likelihood of pain, underscoring how imbalances between limbs act as a critical factor in running mechanics and joint health.

Age also showed a relationship with increased probability of pain, possibly reflecting cumulative mechanical stress and long-term movement adaptations. However, variables such as peak power and muscle mass were not significant predictors of functionality when analyzed alongside other factors. Overall, this study offers an integrated perspective on the biomechanical correlations that influence knee functionality in recreational female runners. The findings highlight the importance of personalized interventions aimed at correcting strength asymmetries, optimizing body composition, and promoting training strategies that enhance symmetrical lower-limb strength. Beyond presenting data, the purpose of this study is to provide meaningful tools that help women who have embraced running as part of their lifestyle to do so with greater safety, improved joint health, and long-term continuity.

Key Words: Recreational female runners, muscle strength, body composition, compensation patterns, knee functionality, strength asymmetry.

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