https://e-kjhp.org

pISSN 2234-2141
eISSN 2093-5676

Korean Journal of Health Promotion

KJHP

VOL. 25 / NO. 4 / December 2025

Korean Society for Health Promotion and Disease Prevention

Korean Journal of Health Promotion
VOL. 25 / NO. 4 / December 2025
pages. 111-154
Korean Society for Health Promotion and Disease Prevention

Korean Journal of Health Promotion
KJHP

Korean Journal of Health Promotion

KJHP

pISSN: 2234-2141 • eISSN: 2093-5676
https://e-kjhp.org

VOL. 25 / NO. 4 / December 2025

Aims and Scope

The *Korean Journal of Health Promotion (KJHP)* is an open access, multidisciplinary journal dedicated to publishing high-quality research in various areas of the medical, nursing, nutritional, physical educational, epidemiological, and public health sciences associated with health promotion and disease prevention. *KJHP*, which has been published continuously since 2001, is an official journal of the Korean Society for Health Promotion and Disease Prevention.

The aim of the *KJHP* is to advance and disseminate new knowledge and scientific information in all the areas associated with health promotion and disease prevention. KJHP publishes original articles, narrative reviews, systematic reviews and meta-analyses, letters to the editor, and perspectives in English.

Abbreviation

The correct abbreviation for abstracting and indexing purposes is *Korean J Health Promot*.

This journal is financially supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government.

Open Access

Article processing charge

No review fees are charged for all the submitted articles. Article processing charges are required for publication in the *KJHP*. Publication fees for all the accepted original or review articles are 300,000 Korean Won (250 US dollars). Additionally, if the article exceeds 6 pages of the journal, additional fees (50,000 Korean Won or 40 US dollars per extra page) will be charged.

Publisher: President, Sung SUNWOO, MD, MPH, PhD
Department of Family Medicine, Asan Medical Center
Korean Society for Health Promotion and Disease Prevention

Editor-in-Chief: Seung-Kwon MYUNG, MD, PhD
Department of Family Medicine, National Cancer Center
Department of Public Health & AI, National Cancer Center Graduate School of Cancer Science and Policy

Editorial Office
Korean Society for Health Promotion and Disease Prevention
Department of Family Medicine, Asan Medical Center, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea
Tel: +82-2-3010-3820 Fax: +82-2-3010-3815 E-mail: kshpdp@amc.seoul.kr

Printing Office
M2PI
#805, 26 Sangwon 1-gil, Seongdong-gu, Seoul 04779, Korea
Tel: +82-2-6966-4930 Fax: +82-2-6966-4945 E-mail: support@m2-pi.com

Korean Journal of Health Promotion
KJHP

Editors

Korean Journal of Health Promotion
KJHP

Contents

VOL. 25 / NO. 4 / December 2025

Review Article

Korean J Health Promot 2025;25(4):111-126
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00164

Korean Journal of Health Promotion
KJHP

Field Applicability of Cognitive–Motor Dual-Task Assessment in Anterior Cruciate Ligament Rehabilitation: A Systematic Review of Psychometric, Physiological, and Translational Frameworks

Jun Woo KWON, MEd

Department of Physical Education, Seoul National University, Seoul, Korea

ABSTRACT

Background: Anterior cruciate ligament rehabilitation increasingly emphasizes the integration of cognitive and motor recovery. Traditional strength or balance tests fail to capture attentional control and movement coordination under cognitive load. Cognitive–motor dual-task paradigms address this gap, yet existing studies are fragmented by heterogeneous designs and limited psychometric validation. This review proposes a structured four-component framework—comprising cognitive task, sensor modality, outcome metric, and protocol standardization—to unify assessment approaches and enhance clinical applicability.

Methods: A systematic narrative synthesis was performed across PubMed, Scopus, and Web of Science (2010–2025). Thirty-seven studies employing cognitive–motor dual-task paradigms in anterior cruciate ligament or anterior cruciate ligament reconstruction contexts were analyzed. Evidence was categorized into behavioral, kinematic, and physiological domains, focusing on psychometric properties including validity, reliability, responsiveness, and feasibility for clinical translation.

Results: Dual-task conditions consistently revealed prolonged reaction time, higher error rates, and asymmetrical movement patterns undetected by single-task tests. Wearable technologies, including inertial measurement units and smart insoles, achieved near-laboratory validity and rapid setup. Behavioral measures demonstrated strong reliability, whereas physiological modalities such as electroencephalography, functional near-infrared spectroscopy, heart rate variability, and electrodermal activity provided mechanistic insights with variable reproducibility.

Conclusions: This review advances dual-task assessment from exploratory research to a psychometrically grounded clinical framework. By integrating behavioral, kinematic, and physiological measures, it defines a wearable-based strategy that connects laboratory precision with field feasibility. Future priorities include multicenter validation, creation of normative datasets and clinical thresholds, and establishment of open-data infrastructures to ensure reproducibility. Standardized, psychometrically rigorous dual-task assessment may become a core tool for individualized rehabilitation and safe return to sport.

Keywords: Cognitive–motor dual-task, Wearable technologies, Psychometric properties, Anterior cruciate ligament rehabilitation, Standardization

Received: September 12, 2025; **Revised:** October 24, 2025; **Accepted:** November 16, 2025

Corresponding author: Jun Woo KWON, MEd
Department of Physical Education, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea
Tel: +82-2-880-7788 Fax: +82-2-872-2867 E-mail: bichoncontin@gmail.com

INTRODUCTION

Anterior cruciate ligament (ACL) injury remains a major challenge in sports medicine, with high re-injury rates and incomplete neuromotor recovery despite surgical and rehabilitative advances [1]. Traditional metrics focused on isolated strength or kinematics fail to capture the cognitive–motor complexity required in real play [2,3].

Growing interest in cognitive–motor dual-task paradigms—combining motor execution with concurrent cognitive demands—reflects this gap [3]. This conceptual foundation traces back to classic work in motor control and attention, which first demonstrated how divided attention impairs postural stability and motor coordination [1,4]. Subsequent models expanded these principles to the organization of executive functions and the neural bases of dual-task interference [5,6].

In sports contexts, the integration of cognitive load theory with injury-prevention frameworks provided the first rationale for applying dual-task assessment to athletic performance [7].

These seminal frameworks on cognitive–motor interference were later extended from neurological and aging contexts to athletic performance, providing the theoretical basis for dual-task assessment in rehabilitation. While dual-task testing has been validated in neurological and aging populations, its translation to athletic rehabilitation remains limited [4]. The present review extends these paradigms to ecologically valid, field-ready contexts relevant to return-to-sport (RTS) [8].

Recent systematic reviews have reiterated familiar issues-heterogeneous methods, inconsistent dual-task cost (DTC) reliability, and lack of standardized frameworks-without proposing actionable solutions [4,8]. Moreover, while wearable-based measures are increasingly adopted, psychometric robustness (e.g., reliability, responsiveness) and physiological standardization (heart rate variability [HRV], electrodermal activity [EDA]) remain fragmented, hindering clinical translation. Meta-analyses have debated DTC reliability and interpretability but offered no standardized cutoffs or psychometric benchmarks [9,10]. This review addresses these gaps by critically appraising reproducibility across domains and establishing a framework for operationalization in ACL rehabilitation [2,3].

Unlike prior descriptive syntheses, this review directly compares measurement modalities (HRV vs. EDA; inertial measurement unit [IMU] vs. motion capture [MoCap]) and evaluates which outcome domains show the strongest validity, reliability, and responsiveness [9,11]. The structured four-component framework—cognitive task, sensor modality, outcome domain, and testing protocol—enables systematic comparison and practical standardization [4,8].

Focusing on affordable wearable technologies (IMUs, HRV, EDA), this review bridges laboratory precision and clinical feasibility [9,11]. It reframes dual-task testing from a neurological construct to an applied sports-medicine tool, adapting it to high-demand, decision-based athletic environments [3,4]. By emphasizing psychometric rigor and translational utility, this work establishes a foundation for standardized, reproducible, and field-deployable assessment in ACL rehabilitation [4,8,9].

METHODS

Review aim and reporting approach

This systematic narrative review synthesizes and critically appraises current evidence on cognitive–motor dual-task assessment in ACL rehabilitation, with a particular focus on wearable and low-cost technologies that enable field application.

Although not a systematic meta-analysis, the review process adhered to transparent and pre-specified methodological steps, including eligibility criteria, search strategy, and multi-stage screening using the PRISMA-lite framework.

Data sources and search strategy

Literature searches were conducted in PubMed, Scopus, Web of Science, and Google Scholar.

Two separate search streams were used to broaden coverage:
(1) ACL+dual task, and
(2) ACL+wearable.

A preliminary search using the combined term ACL+dual task+wearable yielded fewer than 20 records, indicating that integrated research bridging cognitive–motor paradigms and wearable assessment remains scarce.

To ensure sufficient coverage, records retrieved from the four databases were aggregated and imported into Rayyan for reference management and duplicate removal. Following deduplication, 1,035 unique studies were retained for full-text screening.

Representative search syntax combined controlled vocabulary and free-text terms using Boolean operators

1) ACL & rehabilitation context: (“anterior cruciate ligament” OR ACL) AND (rehabilitation OR “return to sport” OR RTS)
2) Dual-task/cognitive load: (“dual-task” OR “dual task” OR “cognitive load” OR “divided attention” OR “inhibitory con-

trol" OR "reaction time" OR "Stroop" OR "n-back")

3) Wearable/low-cost tools: ("wearable" OR "inertial measurement unit" OR IMU OR acceleromet* OR gyroscop* OR "heart rate variability" OR HRV OR "electrodermal activity" OR EDA OR "mobile app")

Screening and eligibility assessment were performed in six sequential stages, based on predefined inclusion and exclusion criteria which is provided in Table 1, and the full PRISMA flow is summarized in Fig. 1.

Data extraction and items

From each study we extracted: study design; sample (ACL status, stage, athletic level); setting (clinic/field/lab-hybrid); cognitive task type (Stroop, n-back, Go/NoGo, etc.); motor task (gait, hop, cutting, landing); device(s) (IMU placement/specs, HRV/EDA modality, app); primary outcomes (e.g., reaction time [RT], accuracy, DTC, asymmetry, HRV indices, EDA features); any psychometric evidence (validity vs. gold standard, test–retest reliability, responsiveness); and key feasibility notes (cost, time, setup).

Risk-of-bias and psychometric notes (narrative)

Given heterogeneity and our narrative scope, we did not run a formal tool-based risk-of-bias meta-analysis. However, we qualitatively flagged internal validity threats (e.g., randomization, blinding), measurement validity (agreement vs. MoCap or force plates when available), reliability (intraclass correlation coefficient [ICC]/test–retest), and responsiveness (standardized response mean [SRM], minimal detectable change [MDC]) where reported. These elements inform the domain-level judgments in the Results/Discussion.

Synthesis approach

We performed a qualitative, domain-organized synthesis: behavioral, physiological, and kinematic outcomes. Within each domain we prioritized critical comparison (e.g., HRV vs. EDA; IMU vs. MoCap), highlighted most/least supported outcome metrics, and identified translational barriers (e.g., sensor drift, signal noise, protocol variability, lack of cut-offs). Where feasible, we mapped findings to RTS phase-specific use cases.

RESULTS

Results were critically synthesized based on the 37 studies summarized in Table 2, 3 [12-48].

Overview of evidence across outcome domains

Evidence from the 37 studies summarized in Table 2, 3 revealed four interconnected outcome domains—behavioral, physiological, kinematic, and cross-domain integration. Foundational works (2015–2018) first demonstrated that dual-task paradigms increase reaction-time cost and motor asymmetry, establishing basic construct validity. More recent investigations (2022–2025) expanded toward sensor-integrated and multimodal neurocognitive testing using IMUs, electromyography (EMG), and functional near-infrared spectroscopy (fNIRS). Across all decades, behavioral reaction-time indices and IMU-based kinematic outcomes provided the strongest psychometric evidence (ICC≥0.8–0.96, SRM ≈ 0.9, setup<20 min). Physiological and integrated indices contributed mechanistic insight but lacked reliability data and consistent calibration. Overall, methodological evolution has shifted from laboratory-bound validation toward field-ready hybrid systems, though standardization re-

Table 1. Eligibility criteria and full-text screening

Stage	Criterion (exclusion focus)	Rationale
① Data reliability	Excluded records with insufficient data accessibility (e.g., abstract-only, duplicate publication, inaccessible full text).	Low reliability
② Participants	Excluded studies including only healthy participants.	Topic mismatch
③ Task type	Excluded studies including only single-task or cognitive-only conditions.	Conceptual inadequacy
④ Measurement tools	Excluded studies using only laboratory-based fixed equipment (e.g., motion capture, electromyography, or force plate without wearable or hybrid configurations).	Technological incompatibility
⑤ Outcome domain	Excluded studies including only self-reported or questionnaire-based assessments.	Outcome mismatch
⑥ Study design	Excluded non-experimental designs (e.g., case reports, descriptive, or protocol-only papers without a comparison group).	Methodological insufficiency
⑦ Final inclusion	Included empirical and review studies employing behavioral (reaction time, error rate), physiological (heart rate variability, electrodermal activity), or kinematic (IMU) measures.	Eligible for qualitative synthesis (systematic review without meta-analysis)

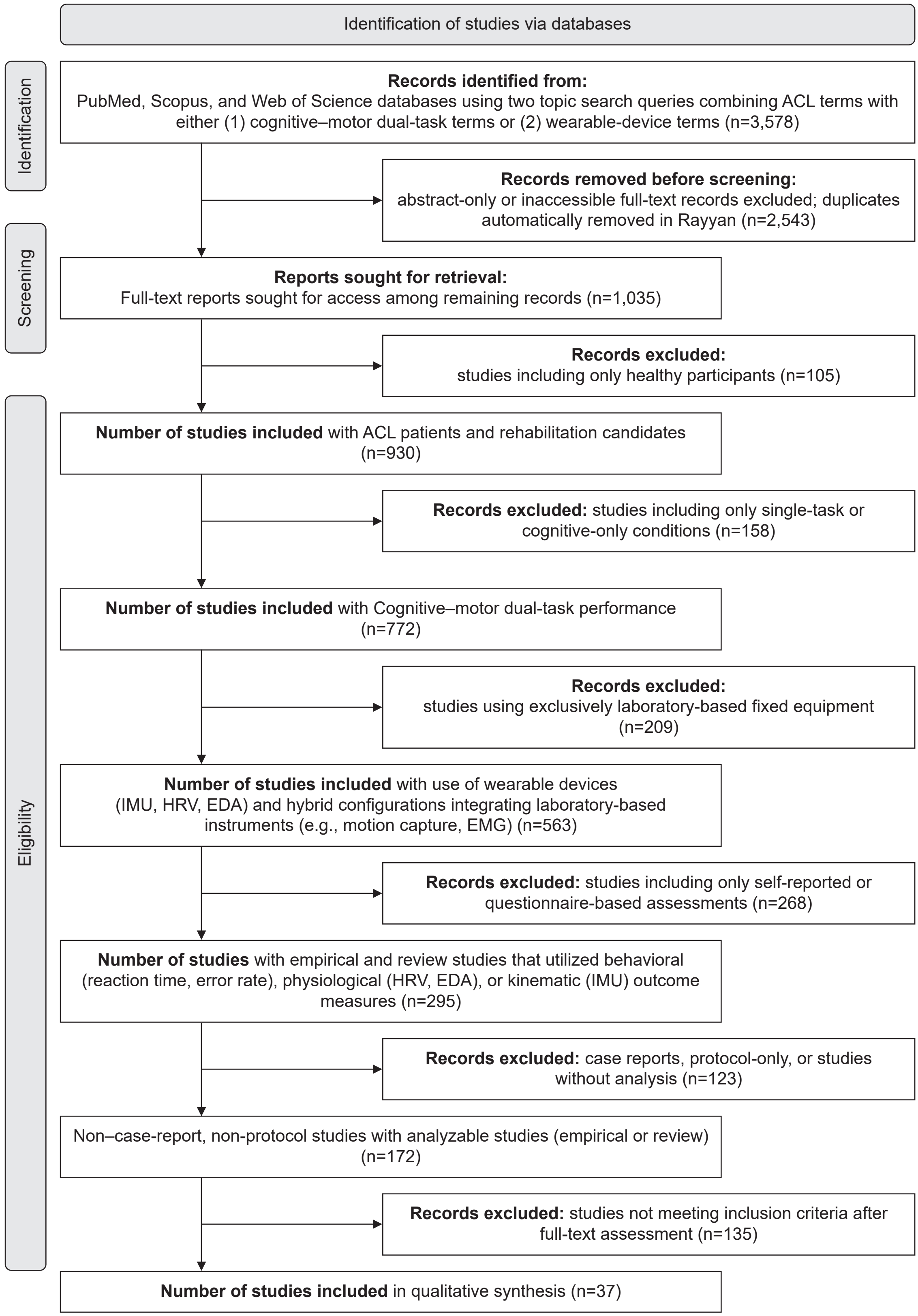

Fig. 1. PRISMA flow diagram of study selection. ACL, anterior cruciate ligament; EDA, electrodermal activity; EMG, electromyography; HRV, heart rate variability; IMU, inertial measurement unit.

Table 2. Study characteristics of included ACL-related wearable and dual-task investigations (n=37)

Study (year)	Sample/injury (n)	Cognitive task (type, brief)	Motor task (type)	Device/modality (make/model if reported)	Key outcomes (behavioral/physiological/kinematic–brief)	Psychometric notes (ICC, SRM)/ feasibility (setup time, field)
Marques et al. (2022) [12]	11 studies (ACLR review)	–	Functional tasks (jump, gait, stairs)	IMUs (APDM, Xsens, Loadsol)	Bilateral asymmetry detected; wearables ≈ lab accuracy	ICC 0.80–0.96; field-portable
Morris et al. (2023) [13]	191 college athletes (45% injured)	Serial subtraction, fluency	Reactive balance (Push & Release)	IMUs (Opal v2, APDM Inc.)	Dual-task TTS predicted injury risk (HR=1.36/250 msec)	Reliability and test duration not reported
Li et al. (2024) [14]	60 (30 ACLR+30 controls)	–	Walk+hop tests	Flexible insole+IMU	ICC=0.91–0.98 vs. Vicon; LSI ≈ 88%	Portable system; battery life ≈ 12 hours
Nazary-Moghadam et al. (2019) [15]	22 ACLD males+22 healthy controls	Auditory Stroop test (RT+error rate)	Treadmill walking at 3 speeds (low, self-selected, high)	Vicon motion capture (5 cameras, 100 Hz); knee kinematics (LyE)	↑ Gait speed → ↓ knee flexion–extension LyE (ES=0.57); dual-task ↑ RT in ACLD; cognitive load effect ns (P=0.07); ACLD prioritized gait over cognitive task	Within-session reliability reported in earlier companion study; single-session treadmill test; feasible lab setup
Jiménez-Martínez et al. [16] (2025) (systematic review)	25 studies (≈ 670 healthy athletes, ACL risk context)	Dual-task/uncertainty manipulations (math subtraction, Stroop, reaction delay, visual distraction)	Jump-landing/side-step/cutting	Motion capture+ force plate (majority studies)	↑ Knee valgus angle and vGRF under high cognitive load → elevated ACL injury risk; slower RTs reported	Review synthesis (no ICC reported); lab-based tasks; field translation recommended
Jiménez-Martínez et al. [17] (2025) (cross-sectional study)	30 ACLR+30 controls	Go/No-Go (proactive inhibitory control)	–	Computer task (SuperLab)	↑ RT, ↑ commission errors, ↓ accuracy in ACLR group (P<0.05)	Cross-sectional lab study; no ICC reported
Walker (2018) [18]	10 ACLR	Exergame (implicit)	Narrow-based gait	Physilog IMU+EEG/ EMG	↓ Stride time variability (η^2=0.53)	Feasible
Majelan and Habibi (2022) [19]	24 youth volleyball	Visual 5-digit reading	Tuck jump	Kinovea video	↓ Jump perf (η^2=0.588)	Feasible
Avedesian (2024) [20]	Review of athlete studies (across levels)	Visual-motor RT, attention, WM	Jump-landing, cutting, gait	Smartboard, VR/AR, strobe eyewear, motion capture	↓ Knee flexion · ↑ knee load with low cognition; slower RT ↑ injury risk	Good test–retest; field-ready tools; VR setups less practical
Kacprzak et al. (2024) [21]	ACLR/review focus on neurosensory–motor integration	–	–	Narrative/theoretical	Hidden sensorimotor and cortical deficits after ACL injury; integration of sensory and motor networks emphasized	Conceptual; not quantitative
Akbari et al. (2023) [22]	24 college soccer players (18 female, 6 male; 20±1 yr)	Heading a stationary soccer ball during jump (dual-task)	Drop vertical jump (30 cm box → jump & land)	3D motion tracking+force plate	↓ Knee/hip/trunk flexion, ↓ COM; ↑ tibial shear, ↑ trunk lat. flexion, ↑ stiffness → ↑ ACL risk	Reliable (r=0.63–0.91); lab-feasible but setup complex
Lin et al. (2025) [23]	30 male division I athletes (CAI confirmed)	LED light reaction dual-task	Single-leg drop jump (30 cm)	Vicon (200 Hz), Kistler (1,000 Hz), Noraxon EMG (2,000 Hz)	↑ vGRF, ↑ ankle inversion & rotation, ↑ ROM; ↓ RF EMG → ↓ stability, ↑ sprain risk	All completed; good repeatability; lab-feasible but complex setup
Yang et al. (2025) [24]	22 males (11 healthy, 11 with ACL or meniscus injury)	None (pure EMG-based computational task; no behavioral dual-task)	Lower-limb motions: sitting, standing, and stair tasks (SIT, STA, STAND)	Surface EMG (4 muscles: BF, RF, VM, SEM), 1,000 Hz sampling	Dual-branch DL model (DB-WCT-EMGNet): 99.86% accuracy, R^2=0.98, RMSE=1.4°; TL improved patient performance from 85.5%→99.5% accuracy	<50 msec inference time; real-time feasible for rehab/ exoskeleton applications
Song et al. (2023) [25]	Editorial	–	Various rehab	EMG, IMU, VR	Summary of 31 studies	–
Ness et al. (2020) [26]	20 studies (review)	Stroop, n-back	Balance, gait	Force plate, IMU	↑ DTC	–
Disegni et al. (2025) [27]	Pro soccer ACLR	Visual recognition+ACL-RSI	Hop, RSA, match sim	Isokinetic, GPS	"11 to Perf" score	Field-feasible

(Continued on the next page)

Table 2. Continued

Study (year)	Sample/injury (n)	Cognitive task (type, brief)	Motor task (type)	Device/modality (make/model if reported)	Key outcomes (behavioral/physiological/kinematic–brief)	Psychometric notes (ICC, SRM)/ feasibility (setup time, field)
Ghai et al. (2018) [28]	Healthy participants; Exp I: 15, Exp II: 20, Controls: 15 (age ≈ 23–27 yr)	Real-time auditory feedback (pitch-angle, amp-velocity)	Knee repositioning (40°, 75°)	XSENS IMU, headphones	↓ Error with sound; transient adaptation	45 minutes; non-invasive; high compliance
Johnson et al. (2021) [29]	20 healthy	–	SLS (perturbed)	Vicon+EMG	Flexed trunk ↑ co-contraction	ICC>0.8
Davidoviča et al. (2025) [30]	32 youth football players (16 male/16 female; age 14.6±0.5 yr)	–	SLS+3 variations (front/middle/back; 60° knee flexion)	DAid smart socks, NOTCH IMUs, PLUX EMG	Strong correlations: hip adduction ↔ medial COP; knee flexion ↔ GM/GMx (ρ ≈ 0.84); COP2W ↔ GMx (ρ=–0.592); multiple moderate correlations between joint angles, COP and EMG	In-field feasible; non-invasive; session ≈ 45 minutes; high compliance
Lu et al. (2025) [31]	16 healthy older adults (68.4±4.4 yr)	Serial subtraction (counting down by threes from random number 90–100; verbal dual task)	Obstacle crossing on 10 m walkway; obstacle height=10%, 20%, 30% of leg length	8 camera motion system; 3 force plates	↓ Crossing speed (P=0.003); ↑ leading & trailing toe-obstacle clearance (P<0.001); ↑ pelvic anterior/posterior tilt, ↑ swing hip abduction & knee flexion; ↓ stance hip/knee adduction during dual-task	Normality (Shapiro–Wilk), homogeneity (Levene); two-way repeated ANOVA (task×height, α=0.05); power analysis lab setup feasible for older adults
Ptaszyk et al. (2025) [32] (scoping review)	ACL injury/ACLR	–	Pivot-shift, Lachman, hop/jump, gait, JPS	IMUs, accelerometers, force insoles, EM/inductive sensors	Accurate knee angle, load, and symmetry metrics	Easy to implement on-site, but standardization is needed
Lu et al. (2025) [33]	ACLR (n=20)+healthy (n=20)	–	Level walking gait at 3, 6, 12, 24 months post-op	3D motion capture (Vicon MX, UK)+dual force plates (AMTI, USA)	Gradual gait symmetry recovery over 24 months; all angles & GRF normalized except persistent knee extension moment (pKEM) asymmetry	High validity; repeated-measures design; lab-based; feasible for longitudinal tracking
Kuroda et al. (2021) [34]	Narrative review	–	Various rehab	Robotics, IMU, VR	Improved ROM, motivation, adherence	No ICC or SRM; qualitative feasibility only
Baldazzi et al. (2022) [35]	17 healthy male soccer players (21.5±3.2 yr)	–	SLS, CHT; 3 reps per limb (randomized order)	MIMU Gyko & foot; AMTI force plate	Angular velocity>acceleration metrics; dominant>nondominant limb; LSI within 85%–115%	Two-way mixed ICC (absolute agreement); MDC=SEM×1.96×√2; standardized 5-minute warm-up; 3 trials per task; field-feasible protocol
Aditya et al. (2025) [36]	23 studies (MCI/dementia)	Subtraction, recall	Gait	IMU, fNIRS, MRI	↓ Speed, ↑ variability, ↑ PFC HbO_2	ICC=0.8–0.97
Kiminski et al. (2025) [37]	31 female athletes	Catch/fake throw	Drop landing+drill	Force plates+IMU	↓ vGRF 25%, ↑ K:A ratio	ICC=0.90–0.91
Kimura et al. (2017) [38]	45 healthy adults	Visuospatial WM training	Elbow+knee torque tasks	EMG (Delsys)+torque chair	↓ FE2 errors (P<0.01), ↑ WM capacity	15 minutes×2 weeks feasible
Calisti et al. (2025) [39]	43 (21 ACL-injured, 22 healthy; 19–36 yr)	–	Six jump-landings (single/bilateral) under fatigued & non-fatigued states	10-camera Vicon, 2 force plates, OpenSim 4.3	Fatigue ↓ jump height (P=0.001) ↑ Borg CR10; dataset supports analysis of joint kinematics & ACL deficits	Normality (Shapiro–Wilk), ANOVA; 2,199 valid trials; standardized lab setup

(Continued on the next page)

Table 2. Continued

Study (year)	Sample/injury (n)	Cognitive task (type, brief)	Motor task (type)	Device/modality (make/model if reported)	Key outcomes (behavioral/physiological/kinematic–brief)	Psychometric notes (ICC, SRM)/ feasibility (setup time, field)
Detherage et al. (2021) [40]	1 injured vs. 7 controls	Vision RT task	Training drills	Zephyr sensor+GPS	↑ BMI, slower RT, ↓ HR recovery; ANS dysregulation	Feasible; single case
Forelli et al. (2025) [41]	Narrative review (ACLR population; no N reported)	Dual-task, neurocognitive drills	Quadriceps activation, gait, hop, strength	EMG, TMS, H-reflex, dynamometer, motion capture	Persistent AMI (↓ cortical excitability, ↓ CAR, asymmetry<90%), improved with NMES, BFR, dual-task rehab	No ICC reported; clinically feasible phase-based rehab; supports neurocognitive RTS framework
Krishnakumar et al. (2024) [42]	71 studies (4 ACL groups)	–	Multi-tasks (walk, run, jump)	IMUs (Xsens, APDM, etc.)	ML-based models RMSE 0.02–0.04 BW; reliable across sagittal tasks	ICC variably reported; no pooled data; setup ~15–30 minutes typical
Calabrò et al. (2025) [43]	Narrative review (ACLR athletes/patients)	Dual-task (counting, reaction, decision)	Gait, balance, proprioceptive, neuromuscular training	Robotics, VR, biofeedback, wearable sensors, neuromodulation (TMS/TENS)	Neuroplasticity-based rehab ↓ reinjury risk (9%–29%), ↑ coordination & confidence	No ICC; qualitative; feasible but expert setup & cost limit
Ricupito et al. (2025) [44]	17 ACLR	Reverse number recall	Triple hop distance	iPad+iPhones	↓ THD, DTC (full sample): healthy 6.49%–6.66%, post-op 4.32%–4.80%;	Time: NR; low-cost, single-session feasible
Rikken et al. (2024) [45]	15 male basketball players (22.1±2.3 yr)	Visual-attention dual task - FitLights	90° near-full-speed sidestep cut (energy-absorption phase: IC → peak knee flexion)	Xsens MVN IMU system (on-court); FitLights stimulus	↓ Hip flexion (IC & peak), ↓ peak knee flexion, ↑ peak hip external rotation; no ankle changes	No ICC/SRM reported; a-priori G*Power; SPM used; on-court IMU=higher ecological validity
Schwartz et al. (2025) [46]	26 healthy adults	Visual-cognitive (go, inhibit, recall)	5-10-5 & T-test	Dashr timing gates+FitLight	ICC: 0.75–0.99; DTE: –13%; no bias	Laboratory-based setup; no test-duration reported
Sherman et al. (2023) [47]	20 ACLR vs. 20 controls	Go/No-Go visuomotor (virtual soccer)	Foot response	EEG (64ch LRP)+TMS	↓ LRP area, ↑ error, ↑ AMT, ↑ effort	Lab-based EEG/TMS setup; no duration or cost reported
Strong and Markström (2025) [48]	40 ACLR (8–59 months after ACL injury, the gender ratio is 1:1)	Cognitive-motor (decision, inhibition, WM)	Drop vertical jump	8-cam Vicon+FP	↓ flexion, ↑ vGRF, ↓ injured load	Lab-based biomechanical assessment; no explicit ICC or duration reported in text

This table summarizes study design elements, sensor modalities, and outcome domains across ACL injury, ACLR, or risk contexts. Each entry details cognitive and motor task types, wearable or laboratory measurement systems, and reported psychometric and feasibility information.

ACL, anterior cruciate ligament; ACLD, anterior cruciate ligament deficient; ACLR, anterior cruciate ligament reconstruction; AMI, arthrogenic muscle inhibition; AMT, active motor threshold; ANS, autonomic nervous system; AR, augmented reality; BF, biceps femoris; BFR, blood flow restriction; BMI, body mass index; BW, body weight; CAI, chronic ankle instability; CAR, central activation ratio; CHT, crossover hop test; COM, center of mass; COP, center of pressure; COP2W, two-dimensional center of pressure width; DL, deep learning; DTC, dual-task cost; DTE, dual-task effect; EEG, electroencephalography; EM, electromagnetic; EMG, electromyography; ES, effect size; Exp, experimental group; fNIRS, functional near-infrared spectroscopy; FP, force plate; GM, gluteus maximus; GMx, gluteus maximus; GPS, global positioning system; GRF, ground reaction force; HbO_2, oxyhemoglobin; HR, hazard ratio; IC, initial contact; ICC, intraclass correlation coefficient; IMU, inertial measurement unit; JPS, joint position sense; K:A, knee-to-ankle ratio; lat., lateral; LED, light emitting diode; LRP, lateralized readiness potential; LSI, limb-symmetry index; LyE, Lyapunov exponent; MCI, mild cognitive impairment; MDC, minimal detectable change; MIMU, magnetic-inertial measurement unit; ML, machine learning; MRI, magnetic resonance imaging; NMES, neuromuscular electrical stimulation; NR, not reported; ns, not significant; PFC, prefrontal cortex; pKEM, peak knee extension moment; post-op, postoperative; rehab, rehabilitation; RF, rectus femoris; RMSE, root mean square error; ROM, range of motion; RSA, repeated sprint ability; RSI, return to sport after injury scale; RT, reaction time; RTS, return-to-sport; SEM, standard error of measurement; SIT, sit task; SLS, single-leg squat; SPM, statistical parametric mapping; SRM, standardized response mean; STA, stair task; STAND, stand task; TENS, transcutaneous electrical nerve stimulation; THD, triple hop for distance; TL, transfer learning; TMS, transcranial magnetic stimulation; TTS, time-to-stability; vGRF, vertical ground reaction force; VM, vastus medialis; VR, virtual reality; WM, working memory; η^2, eta-squared effect size.

Table 3. Psychometric properties and translational feasibility of wearable and cognitive-motor assessment domains in ACL research (n=37) [14-48]

Domain	Validity (vs. gold standard–summary)	Reliability (test–retest/ICC if reported)	Responsiveness (SRM/MDC if reported)	Feasibility (time/cost/field notes)	Notes (barriers/standardization)
IMU-based kinematics/load (ACL & sport tasks)	IMUs (APDM, Xsens, Loadsol) showed near-lab accuracy vs. Vicon and force plates.	ICC 0.80–0.98 (high); r=0.63–0.91	MDC reported; SRM not routinely stated.	Setup ≈ 15–45 min; portable; battery ≈ 12 hr; field-ready for gait/jump tests	Calibration and sensor placement heterogeneity; need for protocol standardization across vendors
Force-plate/Vicon lab biomechanics	Gold standard for joint angles & vGRF; benchmarked others.	ICC>0.8	SRM/MDC rarely reported; mostly cross-sectional.	Complex setup (>30 min); lab space needed; non-portable	High accuracy but limited ecological validity; cost and operator expertise barriers
EMG-based neuromuscular/AMI indices	EMG valid vs. torque or kinematic output	ICC>0.8	SRM not specified; ML error RMSE ≈ 1.4°	Setup ~45 min; lab-based but portable sensors available	Cross-talk & normalization issues; requires expertise for signal processing
Cognitive dual-task (Go/No-Go, Stroop, math subtraction)	Behavioral validity vs. clinical executive tests	Reliability not consistently reported.	Dual-task cost and error metrics sensitive to deficits (responsiveness supported).	<10 min per test; computer or FitLight portable	Lack of standardized stimulus timing; varied outcome definitions
Visual-motor reaction/FitLight/Smartboard/VR	Valid vs. reaction-time benchmarks	ICC 0.75–0.99	DTE – 13% suggests responsiveness.	Short (<10 min); field-portable except VR (costly)	Light timing accuracy & environment lighting variability; VR less practical in-field
In-field wearables (socks, insoles, GPS)	Valid vs. force plate and Vicon	Strong corr ρ=0.59–0.84; ICC ≈ 0.9	MDC not reported.	Session ≈ 45 min; low cost; non-invasive; high compliance	Need for common data formats and reference frames for joint angles
ML/computational models (IMU+EMG)	Validated vs. Vicon/lab (99.9% accuracy, R^2=0.98)	ICC reported in sub-studies; stable model error RMSE=0.02–0.04 BW	Model error acts as responsiveness index.	Processing real-time <50 msec; feasible for rehab integration	Need for dataset standardization and external validation across tasks
Clinical rehab neurocognitive/robotic systems	Moderate validity vs. functional outcomes	ICC not reported.	Qualitative improvement in coordination and confidence	Costly; expert setup required; clinical phase-based rehab feasible	Cost, training time, and limited standard protocols restrict adoption
Theoretical/narrative frameworks (AMI & sensorimotor)	Conceptual validity only	N/A	N/A	Feasible as review synthesis	Serve as rationale for sensorimotor integration research designs

Synthesizes validity, reliability, responsiveness, and feasibility metrics of wearable and cognitive-motor tools extracted from Table 2. Each domain aggregates studies using similar measurement paradigms (e.g., IMU-based, force-plate, dual-task, neurocognitive, ML-driven systems).

ACL, anterior cruciate ligament; AMI, arthrogenic muscle inhibition; BW, body weight; corr, correlation coefficient; DTE, dual-task effect; EMG, electromyography; GPS, global positioning system; ICC, intraclass correlation coefficient; IMU, inertial measurement unit; MDC, minimal detectable change; ML, machine learning; N/A, not available; rehab, rehabilitation; RMSE, root mean square error; SRM, standardized response mean; vGRF, vertical ground reaction force; VR, virtual reality.

mains incomplete.

Physiological vs. kinematic metrics

Physiological measures (electroencephalography [EEG], fNIRS, EMG, transcranial magnetic stimulation [TMS]) captured cortical and corticomuscular modulation after anterior cruciate ligament reconstruction (ACLR). EEG studies showed reduced lateralized readiness potential amplitude and increased inhibitory drive, whereas fNIRS indicated elevated prefrontal HbO_2—evidence of compensatory neural effort.

However, only a minority reported quantitative reliability; signal noise, motion artifacts, and preprocessing heterogeneity remain major barriers. In contrast, kinematic systems—both MoCap and IMU platforms—demonstrated high concurrent validity (ICC>0.9 vs. Vicon). MoCap retains superior spatial precision, yet IMUs offer greater ecological validity, portability, and cost-efficiency (battery ≈ 12 hr, setup<30 min). Critical comparison shows that while physiological tools explain 'why' motor control changes, kinematic sensors more reliably quantify 'how' it manifests.

Thus, for clinical translation, IMU-based kinematics presently outperform physiological indices in reproducibility and scalability.

Comparative appraisal across domains

Most reliable domain

Behavioral reaction-time measures (Go/No-Go, Stroop) and IMU-derived joint kinematics exhibited the highest test–retest reliability (ICC ≈ 0.83–0.94 and >0.9, respectively). Behavioral protocols are low-cost and adaptable; kinematic systems supply quantitative, objective evidence—together forming the methodological benchmark.

Least validated domain

Physiological indices, especially EEG–fNIRS combinations, remain under-validated. Most relied on directional effects rather than numerical agreement, and few provided ICC or MDC values.

Major translational barriers

Lack of synchronized timing across sensors, inconsistent preprocessing pipelines, and absence of normative reference data. Physiological systems are sensitive to artifact contamination; IMU results vary by filtering algorithms; behavioral tasks lack standardized thresholds for impairment.

Behavioral outcomes

Over two-thirds of included studies employed behavioral paradigms. Dual-task conditions consistently prolonged RTs and elevated error rates among ACLR participants, particularly in inhibitory-control tasks. Later large-scale field studies [13,46] confirmed that 5–10 minutes computerized or FitLight tests maintain reliability (ICC ≈ 0.9) comparable to laboratory versions. These data establish behavioral dual-task metrics as high-throughput, repeatable indicators of neurocognitive function, though heterogeneity in stimuli (auditory vs. visual) and feedback limits cross-study comparability.

Physiological outcomes

Physiological modalities elucidate neural mechanisms but face measurement challenges. EEG and TMS revealed altered motor-cortical excitability and slower preparatory potentials post-ACLR; fNIRS identified compensatory increases in prefrontal cortex activation. Yet quantitative indices (ICC, SRM) were largely absent, and preprocessing variability (artifact rejection, baseline correction) restricts reproducibility. Reliability rarely exceeded qualitative confidence; thus, physiological markers remain exploratory mechanistic indicators rather than clinical endpoints. They provide conceptual validity but limited translational readiness.

Kinematic outcomes

Kinematic assessment represents the most psychometrically mature domain. Across jump-landing, gait, and hop tasks, ACLR groups displayed reduced knee and hip flexion, increased stiffness, and persistent asymmetry—findings repeated across multiple independent datasets. IMU-based systems showed strong agreement with Vicon (ICC>0.9) and MDC ≤5%, with sessions typically <30 minutes. IMUs enable field deployment with minimal loss of accuracy, marking them as the most clinically feasible quantitative metric. Remaining limitations include sensor-placement variability and inconsistent filtering standards that hinder multi-center reproducibility.

Cross-domain integration

Few studies combined multiple modalities (e.g., EEG+TMS; IMU+behavioral tasks). Those that did reported convergent findings—greater cortical inhibition paralleled slower RTs and stiffer landings—but suffered from poor temporal alignment between systems. No investigation achieved full tri-domain synchronization (behavior+physiology+kinematics). Hence, cross-domain integration remains a conceptual frontier requiring unified sampling rates, event-marker synchronization, and harmonized data pipelines.

Feasibility and translational considerations

Feasibility improves as technology miniaturizes

Behavioral<IMU<EEG/fNIRS in both cost and setup complexity. Portable IMUs and smart-sock systems permit 15–20 minutes on-field testing, while physiological setups require controlled laboratory conditions. Barriers include calibration drift, lack of inter-device compatibility, and absence of normative databases linking quantitative asymmetry or reaction-time indices to RTS readiness. Standardized, open-access protocols would markedly enhance translational potential.

DISCUSSION

This discussion interprets, rather than restates, the findings summarized in Table 2, 3 [12-48]. The 37 included studies collectively illustrate how cognitive–motor dual-task paradigms redefine the logic of assessment in ACL rehabilitation. Beyond detecting subtle deficits, they clarify what type of information matters most—the capacity to allocate attention, inhibit inappropriate actions, and coordinate complex movement under cognitive load.

Interpretation and novel contribution

Across the 37 studies in Table 2, 3, dual-task paradigms redefine ACL assessment by linking cognitive control and motor execution rather than treating them as separate constructs. Earlier foundational work demonstrated that adding cognitive load magnifies hidden gait or balance asymmetries. Recent investigations (2022–2025) advanced this concept using wearable IMUs, smart insoles, and neurophysiological recordings to capture how athletes think while they move. The novelty of this synthesis is translational, not technological: it consolidates validated task–device–metric pairings (e.g., Go/No-Go+IMU asymmetry+reaction-time cost) into a framework that can be standardized for RTS decisions. This marks a conceptual shift from measuring capacity (strength, balance) toward quantifying control—the integration of attention, inhibition, and movement under cognitive stress.

Psychometric considerations for clinical adoption

Validity

IMU-based kinematic systems consistently achieved criterion validity versus MoCap (ICC=0.91–0.98; root mean square error [RMSE]<5°). These data confirm that, when placement and filtering are standardized, portable wearables approximate laboratory precision. Physiological modalities (EEG, fNIRS, EMG, TMS) provided only qualitative validity—directional cortical changes without cross-validation against gold standards.

Reliability

Behavioral reaction-time and Go/No-Go metrics (ICC ≈ 0.83–0.94) and IMU kinematics (>0.9) showed reproducibility across sessions, while physiological signals seldom reported ICC or SRM. This imbalance underscores the need for explicit reliability reporting to ensure clinical trust.

Responsiveness

Behavioral DTC (SRM ≈ 0.95) and IMU-derived asymmetry were the most change-sensitive measures of recovery progress, whereas physiological metrics (EEG/fNIRS) lacked quantitative responsiveness. Hence, current hierarchy of clinical readiness is: behavioral>kinematic>physiological.

Comparative appraisal of measurement technologies

Inertial measurement unit vs. motion capture

MoCap remains the spatial-accuracy gold standard but requires fixed-lab environments and extended setup (>30 min). IMUs replicate its joint-angle data with minimal precision loss and superior field portability (setup ≈ 15 min, battery ≈ 12 hr). Their main weakness—axis drift and variable filtering—demands standardized calibration and placement maps. Thus, IMUs represent the most valid and scalable wearable option for ACLR dual-task testing, provided preprocessing is harmonized.

Electroencephalography/functional near-infrared spectroscopy vs. electromyography/transcranial magnetic stimulation

Cortical measures (EEG, fNIRS) uniquely reveal neural workload but suffer from motion artifacts and limited reproducibility. Peripheral indices (EMG, TMS) quantify muscle activation and inhibition (arthrogenic muscle inhibition) reliably but lack ecological field feasibility. Integration of these layers remains conceptually valuable yet technically immature.

Cognitive-task feasibility and selection

Three paradigms dominated the dataset: Go/No-Go, Stroop, and n-back/working-memory tasks.

1) Go/No-Go: shortest administration time (<10 min), robust inhibitory-control sensitivity, feasible in clinical or on-field testing.
2) Stroop: rich diagnostic depth for executive control but language- and color-specific, limiting universal deployment.
3) n-back/working-memory: research-sensitive but prone to learning effects and longer duration (>15 min).

Accordingly, Go/No-Go offers the best balance of sensitivity×feasibility for standardized RTS protocols, while Stroop supports in-clinic evaluation and n-back remains experimental.

Operationalizing a standardized return-to-sport dual-task protocol

Evidence from Table 2, 3 supports a four-component operational model:

1) Task set: reactive landing or sidestep combined with Go/No-Go stimulus (1–3 sec random interval).
2) Measurement domains: behavioral (RT, DTC, accuracy); kinematic (2–4 IMUs on shank/thigh for limb-symmetry and variability); physiological (HRV or EMG optional).
3) Standardization: hardware–software time synchronization, fixed sensor map, ≥100 Hz sampling, pre-registered preprocessing.
4) Interpretation: compare dual vs. single-task performance, limb asymmetry, and week-to-week deltas; composite alert=↑ DTC+↑ IMU asymmetry.

This structure converts dual-task testing from a research paradigm into a psychometrically anchored clinical routine.

Implications and remaining barriers

Technological readiness now surpasses methodological uniformity.

Key translational obstacles include

Non-uniform preprocessing for IMU and physiological data; Lack of normative reference datasets linking dual-task metrics to RTS outcomes; Limited reproducibility across laboratories. Addressing these requires multi-center standardization consortia and open-protocol repositories rather than new hardware. The shift from hardware innovation to methodological reproducibility will define the next phase of ACLR assessment.

Study novelty and future directions

This synthesis is novel in its integration of psychometric rigor with cognitive-motor testing.

Where prior ACL research isolated strength or proprioception, the current framework articulates attention, inhibition, and movement control as measurable, interconnected constructs.

Future research priorities drawn from Table 3 include

Establish consensus pipelines for IMU calibration and physiological preprocessing; Develop large-scale normative datasets for reaction-time and asymmetry metrics; Test lightweight neurophysiological add-ons (portable EEG/fNIRS) to bridge behavioral and kinematic domains; Quantify responsiveness (SRM/MDC) systematically across modalities.

Multidisciplinary perspective

Advancing dual-task-based ACL rehabilitation demands convergence of sport neuroscience, biomechanics, and clinical rehabilitation science. Neurophysiological constructs such as cortical inhibition efficiency can contextualize wearable-derived kinematic metrics, while biomechanical validation ensures measurement fidelity. Ultimately, progress depends less on new sensors than on shared psychometric standards and reproducible methods enabling individualized, data-driven RTS clearance.

Limitations and future directions

Despite consolidating 37 studies, this review remains constrained by the limited scale, cross-sectional design, and uneven psychometric reporting of the existing evidence. Most studies were single-center and short-term, and fewer than half quantified validity or reliability formally. To move from descriptive feasibility to standardized clinical implementation, a prioritized and feasible roadmap is required. The following five actions are ranked by urgency and feasibility within current resources. The summary of the priority roadmap is outlined in Table 4.

Large-scale multicenter validation: most urgent and highest impact

Rationale: Table 2, 3 show strong within-study validity for IMU+reaction-time dual-task frameworks (ICC ≈ 0.9, RMSE<5°), but these have only been demonstrated in isolated cohorts. Without

Table 4. Summary of priority roadmap

Priority	Focus area	Core outcome	Feasibility
1	Multicenter IMU+reaction time validation	External validity & RTS predictive value	High
2	Normative datasets & cut-offs	Diagnostic thresholds for RTS	High
3	Psychometric validation	Reliability/responsiveness evidence	High
4	Neurointegration (EEG/fNIRS)	Mechanistic bridging of domains	Moderate
5	Data infrastructure	Reproducibility & global benchmarking	Moderate – scalable with collaboration

EEG, electroencephalography; fNIRS, functional near-infrared spectroscopy; IMU, inertial measurement unit; RTS, return-to-sport.

multicenter replication, external validity and sport-specific generalizability remain unknown.

Objective: Conduct coordinated, multicenter studies using standardized Go/No-Go+IMU protocols to assess inter-site reproducibility and predictive validity for RTS outcomes.

Feasibility: Wearables are already field-ready (setup<20 min, battery ≈ 12 hr). Cloud-based data sharing and shared preprocessing pipelines make multicenter implementation technically achievable within current infrastructure.

Normative datasets and return-to-sport cut-off thresholds: high priority

Rationale: No study in Table 2, 3 established normative reference values for DTC %, reaction-time delay, or limb-symmetry index. Such benchmarks are essential to move from descriptive monitoring to diagnostic decision-making.

Objective: Aggregate multicenter data to derive age-, sex-, and sport-stratified norms, anchored to verified psychometric indices (ICC, SRM, MDC).

Feasibility: Highly achievable with current IMU and behavioral datasets; normative ranges could be generated within one to two collaborative study cycles.

Systematic psychometric validation of wearable-based measures: essential foundation

Rationale: Table 2, 3 report variable reliability (IMU ICC=0.85–0.98; behavioral ≈ 0.83–0.94) but inconsistent test–retest or MDC data. Without these, clinicians cannot distinguish true recovery from measurement noise.

Objective: Replicate IMU-MoCap concurrent validity, and determine responsiveness (SRM) and MDC for field protocols.

Feasibility: Requires repeated-session designs rather than new hardware; easily realizable within existing rehabilitation timelines.

Stepwise neurointegration (electroencephalography/functional near-infrared spectroscopy+inertial measurement unit): mid-term opportunity

Rationale: Physiological systems in Table 2 (EEG, fNIRS, TMS) revealed meaningful cortical activation patterns but lacked reproducibility. Integrating portable EEG/fNIRS with behavioral-kinematic data could bridge motor and neural control levels.

Feasibility: Currently limited by cost, setup time, and artifact control. Short-term use should remain pilot-scale, yet emerging compact EEG/fNIRS modules and automatic synchronization with IMU streams make broader integration plausible within 3–5 years.

Open data infrastructure and shared pipelines: mid-term but foundational

Rationale: Inconsistent filtering, sampling, and preprocessing pipelines were the dominant methodological barriers identified in Table 2, 3. Without common schemas, multicenter validation cannot produce comparable outputs.

Objective: Develop an open, standardized repository containing sensor metadata (task type, sampling rate, sensor placement) and harmonized preprocessing scripts.

Feasibility: Academia–industry collaborations can leverage existing open-source analytics; implementation is realistic within current technical ecosystems.

Overall synthesis

The most urgent need is multicenter replication of the validated IMU+reaction-time dual-task paradigm, immediately followed by the creation of normative datasets and psychometric reliability frameworks. Neurointegration and open-data infrastructure represent the next strategic phase, enabling mechanistic insight and cross-laboratory reproducibility. Advancing along this sequence will convert current heterogeneous dual-task studies into a standardized, evidence-anchored clinical system for ACL rehabilitation and RTS decision-making.

CONCLUSION

Cognitive–motor dual-task assessment marks a conceptual and methodological shift in ACL rehabilitation—from isolated biomechanical or strength evaluations to ecologically valid testing that mirrors the cognitive–motor demands of real-sport environments. Evidence synthesized from the 37 studies in Table 1, 2 demonstrates that when behavioral, kinematic, and physiological indices are combined, clinicians can detect residual neurocognitive-motor deficits that conventional single-task tests overlook.

Integrated evidence and clinical meaning

Behavioral reaction-time and accuracy metrics showed excellent reproducibility (ICC ≈ 0.83–0.94), while IMU-based kinematics achieved near-laboratory validity versus MoCap (ICC>0.9, RMSE<5°). These complementary domains—attention control and movement symmetry—form the most psychometrically mature foundation for clinical translation. Physiological measures (EEG, fNIRS, HRV) provided mechanistic insight but remain limited by preprocessing heterogeneity and insufficient test–retest data. Thus, dual-task assessment now offers a structured, evidence-anchored framework capable of quantifying how athletes allocate attention, inhibit actions, and coordinate movement under cognitive load.

Novel contribution

The novelty of this synthesis lies not in proposing new sensors, but in unifying validated task–device–metric combinations—such as Go/No-Go tasks coupled with IMU-derived asymmetry and reaction-time cost—into a standardized, psychometrically grounded template. By embedding validity, reliability, and responsiveness within each measurement domain, the review advances dual-task testing from experimental feasibility toward clinical actionability for RTS decisions. This transition reframes cognitive–motor assessment as an applied, data-driven component of individualized ACL rehabilitation.

Strategic priorities for continued development

Progress toward full clinical deployment depends on sequential, feasible steps grounded in the current evidence base:

1) Multicenter validation of the IMU+reaction-time framework (most urgent)

Large-scale trials across rehabilitation centers should verify reproducibility and external validity of standardized dual-task protocols.

2) Normative datasets and RTS cut-off thresholds (high priority)

Pooling multicenter data will enable creation of reference ranges and cut-offs for DTC and reaction-time delay, allowing objective RTS classification by age, sex, sport, and graft type.

3) Comprehensive psychometric validation (essential foundation)

Systematic evaluation of test–retest reliability, sensitivity to change, and MDC will distinguish true recovery from measurement noise.

Mid-term opportunities

Incremental neurointegration-linking portable EEG or fNIRS with behavioral-kinematic data—offers deeper insight into cortical mechanisms of motor control, though short-term feasibility remains limited by cost and setup demands. Parallel development of open, standardized data infrastructures for preprocessing, metadata exchange, and cloud-based sharing will enhance reproducibility, accelerate meta-analyses, and enable global benchmarking across laboratories.

Translational outlook

Wearable-enabled dual-task assessment now bridges the gap between high-precision laboratory systems and field-ready clinical applications. With continued standardization, multicenter collaboration, and psychometric rigor, dual-task testing is poised to become a cornerstone of personalized, evidence-based ACL rehabilitation, transforming cognitive–motor assessment from a research innovation into a clinically validated, globally scalable standard that improves both safety and effectiveness in modern sports medicine.

ORCID

Jun Woo KWON, https://orcid.org/0009-0006-0635-9649

AUTHOR CONTRIBUTIONS

Jun Woo KWON had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Author reviewed this manuscript and agreed to individual contributions.

Conceptualization, data curation, formal analysis, investigation, methodology, validation, writing–original draft, reviewing

& editing: JWK.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

FUNDING

None.

DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

REFERENCES

1. Palmieri-Smith RM, Lepley LK. Quadriceps strength asymmetry after anterior cruciate ligament reconstruction alters knee joint biomechanics and functional performance at time of return to activity. Am J Sports Med 2015;43(7):1662-9.
2. Zamankhanpour M, Sheikhhoseini R, Letafatkar A, Piri H, Asadi Melerdi S, Abdollahi S. The effect of dual-task on jump landing kinematics and kinetics in female athletes with or without dynamic knee valgus. Sci Rep 2023;13(1):14305.
3. Park JM, Park S, Jee YS. Rehabilitation program combined with local vibroacoustics improves psychophysiological conditions in patients with ACL reconstruction. Medicina (Kaunas) 2019;55(10):659.
4. Yung KK, Ardern CL, Serpiello FR, Robertson S. A framework for clinicians to improve the decision-making process in return to sport. Sports Med Open 2022;8(1):52.
5. Davies GJ, McCarty E, Provencher M, Manske RC. ACL return to sport guidelines and criteria. Curr Rev Musculoskelet Med 2017;10(3):307-14.
6. Golberg E, Sommerfeldt M, Pinkoski A, Dennett L, Beaupre L. Anterior cruciate ligament reconstruction return-to-sport decision-making: a scoping review. Sports Health 2024;16(1):115-23.
7. Esmaeili Bijarsari S. A current view on dual-task paradigms and their limitations to capture cognitive load. Front Psychol 2021;12:648586.
8. Chaaban CR, Turner JA, Padua DA. Think outside the box: incorporating secondary cognitive tasks into return to sport testing after ACL reconstruction. Front Sports Act Living 2023; 4:1089882.
9. Boffet A, Arsac LM, Ibanez V, Sauvet F, Deschodt-Arsac V. Detection of cognitive load modulation by EDA and HRV. Sensors (Basel) 2025;25(8):2343.
10. Tronstad C, Amini M, Bach DR, Martinsen ØG. Current trends and opportunities in the methodology of electrodermal activity measurement. Physiol Meas 2022;43(2):02TR01.
11. Arlotti JS, Carroll WO, Afifi Y, Talegaonkar P, Albuquerque L, Burch V RF, et al. Benefits of IMU-based wearables in sports medicine: narrative review. Int J Kinesiol Sports Sci 2022; 10(1):36-43.
12. Marques JB, Auliffe SM, Thomson A, Sideris V, Santiago P, Read PJ. The use of wearable technology as an assessment tool to identify between-limb differences during functional tasks following ACL reconstruction. A scoping review. Phys Ther Sport 2022;55:1-11.
13. Morris A, Fino NF, Pelo R, Cushman DM, Monson NE, Jameson T, et al. Reactive postural responses predict risk for acute musculoskeletal injury in collegiate athletes. J Sci Med Sport 2023;26(2):114-9.
14. Li H, Wang L, Liu D, Lin Y, Xin Y, Zhang Q, et al. Evaluating an advanced system with flexible dielectric insole and inertial sensors for post-ACL reconstruction assessment. Surf Interfaces 2024;48:104220.
15. Nazary-Moghadam S, Salavati M, Esteki A, Akhbari B, Keyhani S, Zeinalzadeh A. Gait speed is more challenging than cognitive load on the stride-to-stride variability in individuals with anterior cruciate ligament deficiency. Knee 2019;26(1):88-96.
16. Jiménez-Martínez J, Gutiérrez-Capote A, Alarcón-López F, Leicht A, Cárdenas-Vélez D. Relationship between cognitive demands and biomechanical indicators associated with anterior cruciate ligament injury: a systematic review. Sports Med 2025;55(1):145-65.
17. Jiménez-Martínez J, Gutiérrez-Capote A, Madinabeitia I, Cárdenas D, Alarcón F. Cognitive control after ACL reconstruction: a cross-sectional study on impaired proactive inhibition compared to healthy controls. Brain Sci 2025;15(5):497.
18. Walker L. Gait-related cognitive changes associated with anterior cruciate ligament injury: a single center, observational & longitudinal usual-care-controlled pilot-RCT assessing a motor learning based therapy [master's thesis]. Eidgenössische Technische Hochschule Zürich; 2018. English.
19. Majelan AS, Habibi J. The effect of dual-task on tuck jump performance in volleyball players with dynamic knee valgus. Int J Health Sci 2022;6(S7):6517-26.

20. Avedesian JM. Think fast, stay healthy? A narrative review of neurocognitive performance and lower extremity injury. Musculoskelet Sci Pract 2024;74:103186.
21. Kacprzak B, Stanczak M, Surmacz J. Anterior cruciate ligament (ACL) injury hidden in the complex sensorimotor system. J Orthop Sci Res 2024;5(2):1-23.
22. Akbari H, Kuwano S, Shimokochi Y. Effect of heading a soccer ball as an external focus during a drop vertical jump task. Orthop J Sports Med 2023;11(4):23259671231164706.
23. Lin JZ, Hung MH, Ko BJ, Lee HJ. Analysing lower limb motion and muscle activation in athletes with ankle instability during dual-task drop-jump. Sports Biomech 2025;24(7):1899-913.
24. Yang Y, Tao Q, Li S, Fan S. EMG-based dual-branch deep learning framework with transfer learning for lower limb motion classification and joint angle estimation. Concurr Comput Pract Exp 2025;37(23-24):e70263.
25. Song Q, Wang L, Kong PW, Wei F, Wang D, Li L. Editorial: biomechanical performance and relevant mechanism of physical medicine and rehabilitation for neuromusculoskeletal disorders. Front Physiol 2023;14:1290172.
26. Ness BM, Zimney K, Schweinle WE, Cleland JA. Dual-task assessment implications for anterior cruciate ligament injury: a systematic review. Int J Sports Phys Ther 2020;15(6):840-55.
27. Disegni E, Memain G, Bouvet J, Gaspar M, Maille R, Tamalet B, et al. The "11 to Perf Score", a test for professional players returning to soccer after anterior cruciate ligament reconstruction. J Clin Med 2025;14(1):11.
28. Ghai S, Schmitz G, Hwang TH, Effenberg AO. Auditory proprioceptive integration: effects of real-time kinematic auditory feedback on knee proprioception. Front Neurosci 2018;12:142.
29. Johnson KA, Nozu S, Shields RK. Trunk angle modulates feedforward and feedback control during single-limb squatting. J Funct Morphol Kinesiol 2021;6(4):82.
30. Davidoviča A, Davidovičs S, Semjonova G, Katashev A, Oks A, Lancere L, et al. Correlation of biomechanical variables of lower extremity movement during functional tests and tasks in youth league football players: cross-sectional correlation study. JMIR Form Res 2025;9:e69046.
31. Lu SH, Kuan YC, Wu KW, Wang TM, Lu TW. Cognitive-motor dual task induces strategic kinematic adjustments with increased toe-obstacle clearance for older adults during obstacle crossing. PLoS One 2025;20(10):e0334321.
32. Ptaszyk O, Boutefnouchet T, Cummins G, Kim JM, Ding Z. Wearable devices for the quantitative assessment of knee joint function after anterior cruciate ligament injury or reconstruction: a scoping review. Sensors (Basel) 2025;25(18):5837.
33. Lu Y, Guo J, Zhang S, Yu Y, Ao Y, Huang H, et al. Progressive alterations in gait biomechanical symmetry within 2 years post–anterior cruciate ligament reconstruction. J Phys Conf Ser 2025;3101:012010.
34. Kuroda Y, Young M, Shoman H, Punnoose A, Norrish AR, Khanduja V. Advanced rehabilitation technology in orthopaedics-a narrative review. Int Orthop 2021;45(8):1933-40.
35. Baldazzi A, Molinaro L, Taborri J, Margheritini F, Rossi S, Bergamini E. Reliability of wearable sensors-based parameters for the assessment of knee stability. PLoS One 2022;17(9):e0274817.
36. Aditya S, Armitage L, Clarke A, Traynor V, Pappas E, Kanchanawong T, et al. Relationship between cognitive abilities and lower-limb movements: can analyzing gait parameters and movements help detect dementia? A systematic review. Sensors (Basel) 2025;25(3):813.
37. Kiminski R, Williams C, Heinert B, Mills O, Cluppert K, Rutherford D, et al. Transfer of post-trial feedback on impacts during drop landings in female athletes. Sports Biomech 2025;24(2):388-402.
38. Kimura T, Kaneko F, Nagahata K, Shibata E, Aoki N. Working memory training improves dual-task performance on motor tasks. J Mot Behav 2017;49(4):388-97.
39. Calisti M, Mohr M, Federolf P. Motion capture data of six jump-landings, fatigued and non-fatigued, after anterior cruciate ligament injury. Sci Data 2025;12(1):1645.
40. Detherage JP, Divine JG, Donaworth MA, Palmer TG, Hagen JA, Hasselfeld KA, et al. Physiological monitoring detected changes during women's soccer anterior cruciate ligament injury. Cureus 2021;13(5):e14838.
41. Forelli F, Moiroux-Sahraoui A, Mazeas J, Dugernier J, Cerrito A. Rethinking the assessment of arthrogenic muscle inhibition after ACL reconstruction: implications for return-to-sport decision-making: a narrative review. J Clin Med 2025;14(8):2633.
42. Krishnakumar S, van Beijnum BF, Baten CTM, Veltink PH, Buurke JH. Estimation of kinetics using IMUs to monitor and aid in clinical decision-making during ACL rehabilitation: a systematic review. Sensors (Basel) 2024;24(7):2163.
43. Calabrò RS, Calderone A, Fiorente N. Neurosciences and sports rehabilitation in ACLR: a narrative review on winning alliance strategies and connecting the dots. J Funct Morphol Kinesiol 2025;10(2):119.
44. Ricupito R, Grassi A, Zanuso M, Torneri P. The influence of cognitive dual tasking on the outcomes of the triple hop test following anterior cruciate ligament reconstruction. Int J Sports Phys

Ther 2025;20(1):40-7.
45. Rikken KTH, Panneman T, Vercauteren F, Gokeler A, Benjaminse A. Increased visual attentional demands alter lower extremity sidestep cutting kinematics in male basketball players. Int J Sports Phys Ther 2024;19(11):1304-13.
46. Schwartz AL, McGlone KA, Norte GE, Richardson RM, Koohestani M, Dudley G, et al. Development and reliability of 2 visual-cognitive dual-task agility assessments for return to sport. J Sport Rehabil [Epub ahead of print] 2025. doi: 10.1123/jsr.2024-0440
47. Sherman DA, Baumeister J, Stock MS, Murray AM, Bazett-Jones DM, Norte GE. Inhibition of motor planning and response selection after anterior cruciate ligament reconstruction. Med Sci Sports Exerc 2023;55(3):440-9.
48. Strong A, Markström JL. Adding secondary cognitive tasks to drop vertical jumps alters the landing mechanics of athletes with anterior cruciate ligament reconstruction. J Biomech 2025;180:112496.

Viewpoint

Korean J Health Promot 2025;25(4):127-129
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00136

Korean Journal of Health Promotion
KJHP

Vitamin D Deficiency: A Modifiable Risk Factor for Recurrent Benign Paroxysmal Positional Vertigo?

Ki Dong KO, MD, Kyoung Kon KIM, MD, and In Cheol HWANG, MD

Department of Family Medicine, Gil Medical Center, Gachon University College of Medicine, Incheon, Korea

ABSTRACT

Benign paroxysmal positional vertigo (BPPV) is a common vestibular disorder characterized by recurrent episodes of vertigo, predominantly affecting middle-aged women. While canalith repositioning maneuvers are generally effective, recurrence is frequent and can significantly impact quality of life. An increasing number of studies have reported an association between vitamin D deficiency and BPPV, especially in recurrent cases. Furthermore, recent meta-analyses and randomized controlled trials suggest that vitamin D supplementation can significantly reduce recurrence rates in patients with BPPV. Despite growing awareness, vitamin D deficiency remains prevalent in Korea. Given the high burden of BPPV and the safety and accessibility of vitamin D supplementation, vitamin D screening and supplementation can be a clinically reasonable and potentially beneficial strategy—particularly for middle-aged women, who are most commonly affected by BPPV, and for BPPV patients with recurrent episodes.

Keywords: Vitamin D deficiency, Benign paroxysmal positional vertigo, Vitamin D

Dear Editor,

Benign paroxysmal positional vertigo (BPPV) is characterized by brief episodes of vertigo triggered by changes in head position. While nationwide data on BPPV in South Korea remain limited, evidence suggests that incidence has been steadily rising over time [1]. International studies estimate an annual incidence of about 0.6%, and a lifetime prevalence of around 2.4% [1]. The condition most commonly affects individuals in their 50s to 60s, and is predominant in women, with a female-to-male ratio ranging from 2:1 to 3:1 [1]. Though canalith repositioning maneuvers, such as the Epley maneuver, typically provide effective symptom relief within a few days, recurrence is common [1]. Studies indicate that 20% to 50% of patients may experience recurrence within a few years of the initial episode [1,2]. Vertigo episodes can significantly disrupt daily functioning and increase the risk of injuries from falls. Furthermore, the recurrent and unpredictable nature of these episodes may lead to psychological distress and a reduction in overall quality of life.

The vertigo associated with BPPV is attributed to the displacement of otoconia, also referred to as canaliths, from the utricle into the semicircular canals. This displacement may result from various etiologies, including age-related degenerative changes, head trauma, or inner ear disorders [1]. However, most BPPV cases are classified as idiopathic, with no clearly identifiable underlying cause [1]. Recent research has increasingly focused on vitamin D deficiency as a systemic metabolic factor potentially contributing to BPPV onset and recurrence [1]. Vitamin D plays a key role in calcium regulation and is therefore essential for maintaining the structural integrity of otoconia, which are composed of calcium carbonate crystals [2]. When vitamin

Received: August 6, 2025; **Revised:** November 3, 2025; **Accepted:** November 4, 2025
Corresponding author: Ki Dong KO, MD
Department of Family Medicine, Gil Medical Center, Gachon University College of Medicine, 21 Namdong-daero 774beon-gil, Namdong-gu, Incheon 21565, Korea
Tel: +82-32-460-3354 Fax: +82-32-460-3354 E-mail: highmove77@naver.com

D levels are low, the biochemical stability of otoconia may be compromised, increasing the likelihood of fragmentation and displacement, which can potentially lead to BPPV [2].

Although findings from individual studies have been somewhat inconsistent, several observational studies have reported a significant association between lower serum vitamin D levels and the occurrence of BPPV, particularly in patients with recurrent episodes [2-4]. A recent systematic review and meta-analysis of 47 observational studies [5] demonstrated that patients with BPPV had lower serum vitamin D levels compared to non-BPPV controls (weighted mean difference: –2.84 ng/mL). Moreover, patients with recurrent episodes had even lower serum vitamin D levels than those without recurrence (weighted mean difference: –5.01 ng/mL), implying a stronger association between lower vitamin D levels and BPPV recurrence. However, these findings are largely based on observational data, which are inherently limited in establishing causality due to the potential influence of confounding factors. For instance, individuals with lower levels of physical or outdoor activity may be predisposed to both lower vitamin D levels and an increased risk of BPPV, independently of any direct causal relationship between the two. A randomized controlled trial conducted in Korea and published in Neurology journal in 2020 found that patients with BPPV and low vitamin D levels (<20 ng/mL) who received daily supplementation of 800 IU of vitamin D had a 24% relative reduction in recurrence rates over 1 year, compared to those who did not receive supplementation [6]. Similarly, a meta-analysis of seven controlled trials indicated that vitamin D supplementation reduced the recurrence rate of BPPV by 59% compared to control groups without supplementation [7]. Nevertheless, the strength of this evidence should be interpreted with caution, as the meta-analysis included only one randomized controlled trial, and the trial itself was not placebo-controlled, which represents a significant methodological limitation. Nevertheless, these findings suggest a possible causal link between lower vitamin D levels and BPPV, and that correcting vitamin D deficiency may help reduce the recurrence of BPPV.

According to results from 119,335 subjects during 2017 to 2022, 7.6% of Korean adults were vitamin D deficient (<10 ng/mL) [8]. Although vitamin D testing and supplementation have become increasingly popular in recent years, a majority of Korean adults are still likely to be vitamin D deficient, because of persistent risk factors such as indoor lifestyles and insufficient sun exposure. Korean medical societies related to menopause and osteoporosis recommend a daily intake of at least 800 IU of vitamin D for postmenopausal women to support bone health and reduce the risk of fractures [9,10].

Although emerging evidence suggests an association between lower vitamin D levels and the occurrence or recurrence of BPPV, the current data are largely derived from observational studies and a limited number of controlled trials with insufficient randomization or blinding. Consequently, the causal relationship between vitamin D deficiency and BPPV remains uncertain. However, taking into account the epidemiological and clinical context of vitamin D as well as the disease burden of BPPV, vitamin D screening and supplementation may be a clinically reasonable and potentially beneficial strategy—particularly for middle-aged women, who are most commonly affected by BPPV, and for BPPV patients with recurrent episodes.

Future research, particularly well-designed, placebo-controlled randomized trials, is needed to clarify whether vitamin D supplementation can reduce BPPV recurrence, to establish appropriate thresholds for vitamin D supplementation, and to determine optimal dosing regimens and target serum levels. Until more robust evidence is available, vitamin D supplementation should be considered cautiously and individualized according to clinical context.

ORCID

Ki Dong KO, https://orcid.org/0000-0003-2181-994X
Kyoung Kon KIM, https://orcid.org/0000-0003-0374-2571
In Cheol HWANG, https://orcid.org/0000-0003-4677-5525

AUTHOR CONTRIBUTIONS

Dr. Ki Dong KO had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: KDK. Investigation: KKK and ICH. Writing–original draft: KDK. Writing–review & editing: all authors.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

FUNDING

None.

DATA AVAILABILITY

Data sharing is not applicable to this article.

ACKNOWLEDGMENTS

We would like to express my gratitude to the patients who provided motivation and insight for this study.

REFERENCES

1. Kim HJ, Park J, Kim JS. Update on benign paroxysmal positional vertigo. J Neurol 2021;268(5):1995-2000.
2. Rhim G, Kim MJ. Vitamin D supplementation and recurrence of benign paroxysmal positional vertigo. Nutrients 2024;16(5):689.
3. Cobb LH, Bailey VO, Liu YF, Teixido MT, Rizk HG. Relationship of vitamin D levels with clinical presentation and recurrence of BPPV in a Southeastern United States institution. Auris Nasus Larynx 2023;50(1):70-80.
4. Ren Y, Li J, Xia F. Assessment of vitamin D deficiency in recurrent BPPV patients: a cross-sectional study. Am J Otolaryngol 2024;45(3):104212.
5. Li Y, Gao P, Ding R, Xu Y, Wang Z, Pei X, et al. Association between vitamin D, vitamin D supplementation and benign paroxysmal positional vertigo: a systematic review and meta-analysis. Front Neurol 2025;16:1560616.
6. Jeong SH, Kim JS, Kim HJ, Choi JY, Koo JW, Choi KD, et al. Prevention of benign paroxysmal positional vertigo with vitamin D supplementation: a randomized trial. Neurology 2020;95(9):e1117-25.
7. Yang Z, Li J, Zhu Z, He J, Wei X, Xie M. Effect of vitamin D supplementation on benign paroxysmal positional vertigo recurrence: a meta-analysis. Sci Prog 2021;104(2):368504211024569.
8. Park J, Choi Y, Cho S, Park H, Kim S, Cho HI, et al. Vitamin D status and reference intervals measured by liquid chromatography-tandem mass spectrometry for the early adulthood to geriatric ages in a South Korean population during 2017-2022. Nutrients 2024;16(5):604.
9. Choi HS, Min YK, Byun DW, Hahn MH, Kim KM, Kim BJ, et al. Korean Society for Bone and Mineral Research task force report: perspectives on intermittent high-dose vitamin D supplementation. J Bone Metab 2017;24(3):141-5.
10. Lee DO, Hong YH, Cho MK, Choi YS, Chun S, Chung YJ, et al. The 2024 guidelines for osteoporosis - Korean Society of Menopause: part I. J Menopausal Med 2024;30(1):1-23.

Original Article

Korean J Health Promot 2025;25(4):130-137
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00157

Korean Journal of Health Promotion
KJHP

Factors Influencing Non-Academic Sedentary Behavior in Korean Adolescents: A Secondary Analysis of the 19th Korea Youth Risk Behavior Survey

Jaeyoung LEE, PhD, RN[1] and So Yeon PARK, PhD, RN[2]

[1]Department of Nursing Science, College of Life and Health Sciences, Kyungsung University, Busan, Korea
[2]College of Nurisng, Dong-A University, Busan, Korea

ABSTRACT

Background: This study examined the factors influencing non-academic sedentary behavior among Korean adolescents, focusing on weekday–weekend differences.

Methods: A secondary analysis was conducted using data from the 2023 Korea Youth Risk Behavior Survey (N=52,880). Sedentary behavior was measured separately on weekdays and weekends. Independent variables included sex, age, and body mass index (BMI; physical characteristics); stress, anxiety, and smartphone overdependence (psychological characteristics); and living with family (social characteristics). Data were analyzed using complex sample general linear models.

Results: Average sedentary time was 206.35 minutes on weekdays and 321.96 minutes on weekends. Sex, age, BMI, anxiety, and smartphone overdependence significantly predicted sedentary behavior on both weekdays and weekends (P<0.05). Stress was significant only on weekends (P=0.012); living with family showed no significant association.

Conclusions: Psychological and behavioral factors substantially influence adolescents' sedentary behavior. In particular, smartphone overdependence and anxiety should be considered, and interventions need to address emotional and contextual factors, including weekday–weekend differences.

Keywords: Sedentary behavior, Adolescent, Psychological stress, Technology addiction

INTRODUCTION

Adolescence is a transitional stage between childhood and adulthood, marked by rapid physical, cognitive, and psychosocial growth, making it a critical period for establishing long-term health habits [1,2]. In Korean society, adolescents spend long hours sitting due to heavy academic workloads, and sedentary behavior during non-academic time has also increased with growing digital device use [3,4]. These behavioral changes pose serious health risks, threatening both physical and mental health. Sedentary behavior, characterized by low energy expenditure, increases cardiovascular disease risk by >34% [5], causes hyperglycemia through insulin resistance, and elevates the risk of metabolic syndrome [5].

According to World Health Organization guidelines on physical activity and sedentary behavior [1], increased sedentary behavior is associated with reduced quality of life, depression, and lower prosocial behavior. Systematic reviews also report

Received: September 4, 2025; **Revised:** October 24, 2025; **Accepted:** October 30, 2025
Corresponding author: So Yeon PARK, PhD, RN
College of Nursing, Dong-A University, 32 Daesingongwon-ro, Seo-gu, Busan 49201, Korea
Tel: +82-51-240-2689 Fax: +82-51-240-2920 E-mail: 156490@dau.ac.kr

anxiety, stress, decreased self-esteem, and sleep disorders [6,7]. The United States Centers for Disease Control and Prevention recommends limiting sedentary behavior based on related studies [8]. In Korea, growing emphasis has been placed on the risks of sedentary behavior among children and adolescents and the need for corresponding guidelines [9]. Despite such demands [10], research on sedentary behavior in Korea remains insufficient, with only preliminary surveys on its prevalence among children and adolescents [11].

Recent studies have examined sedentary behavior as a health behavior influenced by various factors [12]. For adolescents, a multidimensional approach that considers such complex contexts is required. To date, most studies in Korea have focused on physical characteristics such as weight, obesity, and sex [13,14] or on the relationship between subjective health perception [4] or smartphone use time and anxiety levels [15]. Few have analyzed structural relationships where various factors interact simultaneously.

Although adolescents' behavioral patterns may vary depending on differences in activity patterns by weekday vs. weekend, emotional state, and school or home environment, these contexts have not been comprehensively considered [6]. Gorely et al. [16] emphasized that sedentary behavior and physical activity patterns differ by day, time, and social context and with activity type or environmental factors among adolescents.

Accordingly, this study aimed to analyze the factors influencing sedentary behavior among adolescents in a more systematic and comprehensive manner, categorizing the main variables into three domains: physical, psychological, and social characteristics.

Physical characteristics included sex, age, and body mass index (BMI). Sex influences physical activity and media use [17,18], age reflects behavioral characteristics according to developmental stage [18], and BMI indirectly reflects the physical health status of adolescents, which is significantly associated with sedentary time [14] and can be used to predict the level of health risk in adolescents.

Psychological characteristics included perceived stress, anxiety, and smartphone overdependence. Stress and anxiety are common emotional problems during adolescence and closely related to sedentary behavior [4,15]. Smartphone overdependence has recently emerged as a major factor influencing adolescents' daily lives and sedentary time [19]. However, while the relationship between smartphone use and sedentary behavior has been established, temporal patterns (weekdays vs. weekends) remain insufficiently elucidated. Based on the findings of Gorely et al. [16], which reported differences by day and time, it is necessary to examine these aspects in the present study as well.

Social characteristics included cohabitation with family members, which reflects social support and living environment. Living with guardians may influence daily routines and smartphone regulation, thereby affecting sedentary behavior patterns [20].

Therefore, this study aimed to identify the effects of physical (sex, age, and BMI), psychological (perceived stress, anxiety, and smartphone overdependence), and social (living with family) characteristics on non-academic sedentary behavior among Korean adolescents through multivariate analysis.

METHODS

Research design

This study was a secondary analysis on data from the 19th Korea Youth Risk Behavior Survey, conducted in 2023 [21], to identify factors influencing sedentary behavior among adolescents.

Participants

The Korea Youth Risk Behavior Survey is an anonymous, web-based survey conducted annually by the Korea Disease Control and Prevention Agency, targeting middle- and high-school students enrolled in Korea as of April each year. In this study, data from 52,880 adolescents who participated in the 2023 survey were analyzed.

Measurements

Sedentary behavior

Sedentary behavior was assessed using the item, "During the past 7 days, how many hours per day on average did you spend sitting?" Excluding time spent on learning, responses were collected separately for weekdays (Monday to Friday) and weekends (Saturday to Sunday) and converted into minutes. Accordingly, sedentary behavior was analyzed separately for weekdays and weekends.

Physical characteristics

Physical characteristics included sex, age, and BMI. BMI was calculated as kg/m^2.

Psychological characteristics

Psychological characteristics consisted of perceived stress, anxiety, and smartphone overdependence. Stress responses of “very much” and “much” were recoded as “yes,” while those of “a little,” “not much,” and “not at all” were recoded as “no.” Anxiety was measured using the 7-item Generalized Anxiety Disorder Scale. Participants responded to the question, “Over the last 2 weeks, how often have you been bothered by the following problems?” on a 4-point scale ranging from “not at all” (0) to “nearly every day” (3). The total score ranged from 0 to 21, with higher scores indicating greater anxiety. Cronbach’s α in this study was 0.91, consistent with that reported previously [22]. Smartphone overdependence was assessed using the Smartphone Overdependence Scale, which consists of 10 items scored on a 4-point scale from “strongly disagree” (1) to “strongly agree” (4), with the total score ranging from 10 to 40. Higher scores indicate greater overdependence. Cronbach’s α was 0.84 at the time of development [23] and 0.91 in this study.

Social characteristics

Social characteristics included living arrangements, categorized as living with parents versus not living with parents.

Data collection and ethical considerations

The Korea Youth Risk Behavior Survey is a nationally approved statistical survey conducted annually by the Korea Disease Control and Prevention Agency, officially approved by Statistics Korea. Until 2014, the survey underwent review by the Institutional Review Board (IRB) of the Korea Disease Control and Prevention Agency; however, since 2015, it has been exempted from IRB review under the Enforcement Rule of the Bioethics and Safety Act [24]. All participants received information on the purpose and content of the survey and voluntarily consented to participate. The survey was conducted anonymously using a self-administered, web-based questionnaire. Responses were collected in a form that could not identify individuals, and the raw data were provided to researchers by the Korea Disease Control and Prevention Agency. Approval for use of the data in this study was obtained according to procedures outlined on the official Korea Youth Risk Behavior Survey website (https://www.kdca.go.kr/yhs/). This study was exempted from approval by the IRB because it was a secondary data analysis using de-identified, publicly available data. Analyses were performed using secondary data that did not permit the identification of participants.

Data analysis

Data from the Korea Youth Risk Behavior Survey were analyzed using a complex sampling design. Stratification, clustering, weighting, and finite population correction coefficients included in the raw data provided by the Korea Disease Control and Prevention Agency were reflected in the analyses, which were conducted using IBM SPSS Statistics version 29.0 (IBM Corp.). The raw data of this survey contained some nonresponses due to missing value processing for logical errors and outliers. As the item nonresponse rate was low (within 2%), no imputation was performed, and the results were calculated using the available data. The handling of missing values for the variables used in this study was as follows: sedentary behavior data were treated as missing when the reported daily sitting time was 24 hours or 0 minutes. Age values were treated as missing if participants were younger than 12 years or older than 19 years. Height, weight, and BMI values were treated as missing when they were outside the mean ±3·standard deviations for each sex and school grade.

The analysis procedures were as follows: First, sedentary time was analyzed using complex sample descriptive statistics. Second, differences in sedentary behavior according to physical, psychological, and social characteristics were analyzed using complex sample descriptive statistics and a complex sample general linear model (GLM). Third, factors influencing sedentary behavior were analyzed using a complex sample GLM.

Diagnostic statistics for regression assumptions are not provided in the SPSS complex sample GLM procedure; therefore, separate general linear regression analyses were conducted with and without applying sampling weights to exploratorily examine the regression assumptions. Results of assumption testing for the independent variables indicated that tolerance values ranged from 0.71 to 0.98, exceeding the threshold of 0.1, and the variance inflation factor ranged from 1.02 to 1.42, below the cutoff value of 10, indicating no multicollinearity concerns. The Durbin-Watson test, based on the unweighted regression analysis, yielded values between 1.91 and 1.95, close to 2, indicating the absence of autocorrelation. Therefore, the basic assumptions of the regression analyses were considered to be satisfied.

RESULTS

Sedentary behavior among Korean adolescents

The sedentary behaviors of the participants are presented in Table 1. The average weekday sedentary time was 206.35 minutes, while the average weekend sedentary time was 321.96 minutes.

Differences in sedentary behavior according to physical, psychological, and social characteristics of Korean adolescents

Differences in weekday sedentary behavior according to physical, psychological, and social characteristics of the participants were as follows: among physical characteristics, sex (*P*<0.001), age (*P*=0.035), and BMI (*P*<0.001) were significantly associated with weekday sedentary behavior. Among psychological characteristics, stress, anxiety, and smartphone overdependence were significantly associated with weekday sedentary behaviors (*P*<0.001). The social characteristics of living with family showed no statistically significant differences (*P*=0.319) (Table 2).

Differences in weekend sedentary behavior according to physical, psychological, and social characteristics of the participants were as follows: among physical characteristics, sex (*P*<0.001), age (*P*=0.035), and BMI (*P*<0.001) were significantly associated with weekend sedentary behavior. Among psychological characteristics, stress, anxiety, and smartphone overdependence were significantly associated with weekend sedentary behavior (*P*<0.001). The social characteristics of living with family showed no statistically significant differences (*P*=0.065) (Table 2).

Table 1. Sedentary behavior among Korean adolescents

Variable	Subject (n)	Mean±SE (min)
Weekday sedentary behavior	51,715	206.35±0.93
Weekend sedentary behavior	51,241	321.96±1.54

SE, standard error.

Factors influencing sedentary behavior among Korean adolescents

Factors influencing sedentary behavior were analyzed using a complex sample GLM (Table 3). The dependent variable was sedentary behavior, entered separately for weekdays and weekends, and the independent variables included seven factors: physical characteristics (sex, age, and BMI), psychological characteristics (stress, anxiety, and smartphone overdependence), and social characteristics (living with family). Although living with family did not show a significant association with sedentary behavior in the univariate analysis, it was included in the regression model considering its theoretical validity as an important social contextual factor.

The factors influencing weekday sedentary behavior were sex (*P*<0.001), age (*P*<0.001), BMI (*P*<0.001), anxiety (*P*=0.003), and smartphone overdependence (*P*<0.001), all of which showed statistically significant associations. However, stress (*P*=0.370) and living with family (*P*=0.196) were not significantly associated. Compared with female participants, male participants had 7.94 units more weekday sedentary behavior. For each 1-unit increase in age, weekday sedentary behavior decreased by 1.71 units. For each 1-unit increase in BMI, weekday sedentary behavior increased by 1.33 units. For each 1-unit increase in anxiety, weekday sedentary behavior increased by 0.56 units. For each 1-unit increase in smartphone overdependence,

Table 2. Differences in sedentary behavior by physical, psychological, and social characteristics among Korean adolescents (N=52,880)

Variable	Category	Subject (n or mean)	Weighted %/SE	Weekday sedentary behavior[a] (n=51,715)			Weekend sedentary behavior[b] (n=51,241)		
				Mean±SE (min)	t	*P*-value[c]	Mean±SE (min)	t	*P*-value[c]
Physical characteristic									
Sex	Male	26,769	50.6	209.17±1.29	3.58	<0.001	336.91±2.22	10.59	<0.001
	Female	26,111	49.4	203.34±1.17			306.05±1.98		
Age (yr)		15.17	0.02	206.33	−2.11	0.035	321.99	−12.86	0.035
BMI (kg/m²)		21.35	0.03	205.56	6.56	<0.001	321.11	9.20	<0.001
Psychological characteristic									
Stress	Yes	19,699	37.3	210.25±1.34	4.19	<0.001	328.74±2.11	4.91	<0.001
	No	33,181	62.7	204.03±1.06			317.96±1.71		
Anxiety		4.22	0.03	206.35	7.47	<0.001	321.96	7.66	<0.001
Smartphone overdependence		19.29	0.04	206.35	14.58	<0.001	321.96	12.56	<0.001
Social characteristic									
Living with family	No	2,511	4.7	201.84±4.71	−1.00	0.319	310.56±6.32	−1.85	0.065
	Yes	50,362	95.2	206.55±0.93			322.45±1.56		

BMI, body mass index; SE, standard error.
[a]Age (n=51,641), BMI (n=50,362), living with family (n=51,709). [b]Age (n=51,168), BMI (n=49,911), living with family (n=51,235). [c]Complex sample general linear model.

Table 3. Factors influencing weekday and weekend sedentary behavior among Korean adolescents

Variable	Category	Weekday sedentary behavior (n=50,357)				Weekend sedentary behavior (n=49,906)			
		B	SE	t	*P*-value[a]	B	SE	t	*P*-value[a]
(Constant)		160.53	8.63	18.61	<0.001	365.68	14.21	25.74	<0.001
Sex	Male	7.94	1.67	4.75	<0.001	33.36	2.80	11.92	<0.001
	Female	1.00				1.00			
Age		−1.71	0.51	−3.37	<0.001	−11.89	0.81	−14.76	<0.001
BMI		1.33	0.20	6.77	<0.001	3.03	0.30	10.19	<0.001
Stress	Yes	1.46	1.62	0.90	0.370	5.67	2.25	2.52	0.012
	No	1.00				1.00			
Anxiety		0.56	0.19	2.99	0.003	1.37	0.26	5.19	<0.001
Smartphone overdependence		1.85	0.13	14.38	<0.001	2.38	0.18	13.41	<0.001
Living with family	No	−6.00	4.64	−1.29	0.196	0.77	6.15	0.13	0.901
	Yes	1.00				1.00			
R^2		0.008				0.022			
Wald F (*P*-value)		47.13 (<0.001)				104.94 (<0.001)			

BMI, body mass index; SE, standard error.
[a]Complex sample general linear model.

weekday sedentary behavior increased by 1.85 units.

The factors influencing weekend sedentary behavior were sex (*P*<0.001), age (*P*<0.001), BMI (*P*<0.001), stress (*P*=0.012), anxiety (*P*<0.001), and smartphone overdependence (*P*<0.001), all of which showed statistically significant associations. However, living with family was not significantly associated (*P*=0.901). Compared with female participants, male participants had 33.36 units more weekend sedentary behavior. For each 1-unit increase in age, weekend sedentary behavior decreased by 11.89 units. For each 1-unit increase in BMI, weekend sedentary behavior increased by 3.03 units. Adolescents with stress had 5.67 units more weekend sedentary behavior than those without stress. For each 1-unit increase in anxiety, weekend sedentary behavior increased by 1.37 units. For each 1-unit increase in smartphone overdependence, weekend sedentary behavior increased by 2.38 units.

DISCUSSION

This study analyzed the physical, psychological, and social characteristics influencing non-academic sedentary behavior among adolescents and compared differences between weekdays and weekends. The results showed that sex, age, BMI, anxiety, and smartphone overdependence were significant influencing factors on both weekdays and weekends, whereas stress was significantly associated only on weekends. In contrast, living with family was not significantly related to sedentary behavior.

The regression analysis results showed a relatively low explanatory power, with R^2=0.008 for the weekday sedentary behavior model and R^2=0.022 for the weekend model. However, this outcome should be interpreted within the context of social and behavioral research. According to Ozili [25], it is common and acceptable for R^2 values to be relatively low in these fields, since human behaviors—such as adolescent sedentary behavior—are influenced by numerous unobserved factors, including genetic predispositions, environmental cues, social norms, and individual motivations, as well as measurement errors. Therefore, this study was primarily designed not for high predictive accuracy, but rather to identify the specific, statistically significant effects of physical, psychological, and social characteristics on adolescent sedentary behavior.

Among the physical characteristics, sex consistently had a significant effect, with male students reporting longer sedentary times than female students on both weekdays and weekends. This may be related to the tendency of male students to prefer digital device–based sedentary activities, such as gaming and video watching, compared with female students [17,18]. In this study, sedentary time decreased with increasing age, with a more pronounced change observed on weekends. This contrasts with previous studies reporting that sedentary time increases with age among adolescents [26,27] but is consistent with the findings of Lim [14], which indicated that as adolescents advance in grade level, their study time increases and available leisure time decreases. This result may reflect the distinctive academic environment of Korean adolescents, where older students face heavier academic workloads and spend less time in leisure-based sedentary activities. Ibabe et al. [28] found that as adolescents grow older, structured leisure time tends to decrease, and unstructured screen-based activities increase, predicting higher problematic technology use (assessed through indicators such as time spent using mobile devices, social networking, chatting or emailing, and eating while using smartphone). This pattern supports the interpretation that older adolescents' sedentary behavior becomes more academically driven and less discretionary. BMI was positively associated with sedentary behavior on both weekdays and weekends, supporting previous research suggesting that low physical activity may lead to weight gain, while a higher BMI may result in avoidance of activity [16]. During weekdays, relatively structured schedules physically restrict sedentary time among adolescents, whereas on weekends, such restrictions are reduced, leading to increased leisure time involving screen use [29].

Among psychological characteristics, stress was not significantly associated with weekday sedentary behavior but was associated with weekend sedentary behavior. In contrast, anxiety showed a significant positive association with sedentary behavior on both weekdays and weekends, and smartphone overdependence was identified as a predictor of sedentary behavior regardless of the day of the week. Hoare et al. [6] reported a positive relationship between anxiety and media-based sedentary behavior in adolescents, and Pearson and Biddle [30] emphasized that adolescents often engage in screen-based activities as a means of emotional recovery when experiencing stress. Subiron-Valera et al. [31] further reported that in environments with less external control, stress can directly increase screen time. These findings suggest that in autonomous environments, emotional stress may easily translate into immediate pleasure-seeking behaviors.

When experiencing emotional distress, people tend to prioritize immediate mood recovery over long-term goals [32]. From this perspective, sedentary behavior can be interpreted as an emotion-regulation strategy. In particular, the significant increase in sedentary behavior on weekends compared with weekdays suggests that emotional responses are more likely to translate directly into behavior in environments with greater autonomy. Meanwhile, anxiety is not a temporary emotion but a chronic emotional state, and adolescents often cope with it through avoidance strategies such as task avoidance [32]. Sedentary activities often involve media use, which can offer immediate rewards and emotional stability, potentially serving as a coping mechanism for alleviating anxiety [19,29,30]. However, when sedentary activities become habitual, they may negatively affect both physical and emotional health. Therefore, reducing sedentary behavior among adolescents requires interventions that not only limit time but also address the context in which sedentary behavior is used as a coping strategy for stress or anxiety, along with providing emotional support.

Living with family was not significantly associated with sedentary behavior, suggesting that qualitative family dynamics may have a greater influence on adolescents' behavior than cohabitation itself. Bounova et al. [33] emphasized that parental monitoring and communication are key factors in reducing adolescents' screen-related sedentary behavior, highlighting the importance of the parental role. Similarly, Yang et al. [20] reported that parents' excessive smartphone use weakened their ability to regulate their children's media use, underscoring the significance of parental modeling. Taken together, these findings suggest that parenting attitudes and media-related communication are more influential than quantitative indicators such as living arrangement. As this study used secondary data without qualitative family variables, future research should examine these factors in more depth.

In this study, adolescents spent more sedentary time on weekends than on weekdays, with stress and smartphone overdependence exerting stronger effects during weekends. This indicates that in more autonomous environments, such as weekends, emotional factors and exposure to digital media directly influence behavior. These findings suggest that interventions to reduce sedentary behavior among adolescents should consider differences by day of the week and focus on managing emotional factors in highly autonomous contexts.

Through a multidimensional analysis, this study demonstrated that single behavioral guidelines or time-based standards alone are insufficient. Instead, integrated approaches addressing emotional regulation, digital literacy, and age-specific strategies are needed. Anxiety and smartphone overdependence were related to sedentary behavior, indicating that these factors merit careful attention in developing intervention strategies. These findings suggest that intervention strategies should not only focus on limiting screen time but also take into account adolescents' emotional states, patterns of media use, and everyday living environments. To ensure practical applicability, interventions should be implemented through school-based education, parental guidance on balanced media use, and community programs that provide structured leisure activities.

ORCID

Jaeyoung LEE, https://orcid.org/0000-0002-5516-8199
So Yeon PARK, https://orcid.org/0000-0002-0498-6271

AUTHOR CONTRIBUTIONS

Dr. So Yeon PARK had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: all authors. Data curation: JL. Formal analysis: JL. Writing–original draft: all authors. Writing–review & editing: all authors.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

FUNDING

None.

DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

REFERENCES

1. World Health Organization (WHO). WHO guidelines on physical activity and sedentary behaviour [Internet]. WHO; 2020 [cited Aug 3, 2025]. Available from: https://www.who.int/publications/i/item/9789240015128
2. Todd AS, Street SJ, Ziviani J, Byrne NM, Hills AP. Overweight and obese adolescent girls: the importance of promoting sensible eating and activity behaviors from the start of the adolescent period. Int J Environ Res Public Health 2015;12(2):2306-29.
3. Hong E. Effects of smartphone overuse on adolescents' mental health and academic performance based on data from the 2022 Korea Youth Risk Behavior Web-Based Survey. J Korean Acad Sens Integr 2024;22(1):43-53.
4. Kwon M, Lee J. The effects of sedentary behavior on subjective health in Korean adolescents. J Korean Soc Sch Health 2019;32(2):125-34.
5. Liang ZD, Zhang M, Wang CZ, Yuan Y, Liang JH. Association between sedentary behavior, physical activity, and cardiovascular disease-related outcomes in adults: a meta-analysis and systematic review. Front Public Health 2022;10:1018460.
6. Hoare E, Milton K, Foster C, Allender S. The associations between sedentary behaviour and mental health among adolescents: a systematic review. Int J Behav Nutr Phys Act 2016;13(1):108.
7. Barlett ND, Gentile DA, Barlett CP, Eisenmann JC, Walsh DA. Sleep as a mediator of screen time effects on US children's health outcomes: a prospective study. J Child Media 2012;6(1):37-50.
8. U.S. Centers for Disease Control and Prevention. Health and academics [Internet]. U.S. Centers for Disease Control and Prevention; 2024 [cited Aug 3, 2025]. Available from: https://www.cdc.gov/healthy-schools/health-academics/index.html
9. Lee EY, Spence JC, Hwang J, Yi KJ, Jeon JY. Future directions to develop sedentary behaviour guidelines for Korean children and adolescents. Korean J Phys Educ 2015;54(4):503-14.
10. Chaput JP, Carson V, Gray CE, Tremblay MS. Importance of all movement behaviors in a 24 hour period for overall health. Int J Environ Res Public Health 2014;11(12):12575-81.
11. Cho J, Song G. Evidence for sitting time standard guidelines: a narrative review of sedentary behavior. Korean J Meas Eval Phys Educ Sport Sci 2020;22(4):1-12.
12. Rollo S, Gaston A, Prapavessis H. Cognitive and motivational factors associated with sedentary behavior: a systematic review. AIMS Public Health 2016;3(4):956-84.
13. Lee EY, An K, Min J, Jeon JY. Correlates of sedentary behaviour among girls: age, physical activity, and adiposity. J Korean Assoc Phys Educ Sport Girls Women 2016;30(3):253-68.
14. Lim MK. Association between sitting time and BMI-defined low weight and obesity in Korean adolescences. Korean J Health Educ Promot 2016;33(5):1-12.
15. Park KS. Influence of sedentary behavior and smartphone use on the risk of generalized anxiety disorder among adolescents. J Korean Acad Psychiatr Ment Health Nurs 2023;32(4):363-73.
16. Gorely T, Marshall SJ, Biddle SJ, Cameron N. Patterns of sedentary behaviour and physical activity among adolescents in the United Kingdom: project STIL. J Behav Med 2007;30(6):521-31.
17. Hwang IW, Choe JP, Park JH, Lee JM. Association between physical activity, sedentary behavior, satisfaction with sleep fatigue recovery and smartphone dependency among Korean adolescents: an age- and gender-matched study. Int J Environ Res Public Health 2022;19(23):16034.

18. Kim HS, Kim YI. Factors related to health promoting behavior in late school-age children. J Korean Soc Sch Health 2010;23(1):1-10.
19. Jeong A, Ryu S, Kim S, Park HK, Hwang HS, Park KY. Association between problematic smartphone use and physical activity among adolescents: a path analysis based on the 2020 Korea Youth Risk Behavior web-based survey. Korean J Fam Med 2023;44(5):268-73.
20. Yang K, Jang H, Chung GH. The effect of parents' restrictive mediation in smartphone use time on adolescents' smartphone use time: the moderation effect of parents' smartphone use time and adolescents' grade. Fam Cult 2020;32(4):1-28.
21. Korea Disease Control and Prevention Agency, Ministry of Education. The 19th Korea Youth Risk Behavior Survey [Internet]. Korea Disease Control and Prevention Agency; 2024 [cited Jul 10, 2025]. Available from: https://www.kdca.go.kr/yhs/
22. Lee B, Kim YE. The psychometric properties of the Generalized Anxiety Disorder scale (GAD-7) among Korean university students. Psychiatry Clin Psychopharmacol 2019;29(4):864-71.
23. National Information Society Agency. 2016 Digital Culture Forum policy research report [Internet]. National Information Society Agency; 2016 [cited Aug 3, 2025]. Available from: https://library.nia.or.kr/search/10110/contents/7055382
24. Korea Disease Control and Prevention Agency, Ministry of Education. The 12th Korea Youth Yisk Behavior Survey [Internet]. Korea Disease Control and Prevention Agency; 2016 [cited Jul 10, 2025]. Available from: https://www.kdca.go.kr/yhs/
25. Ozili PK. The acceptable R-Square in empirical modelling for social science research. In: Saliya C, editor. Social research methodology and publishing results: a guide to non-native English speakers. IGI Global Scientific Publishing; 2023. p. 134-43.
26. Hardy LL, Bass SL, Booth ML. Changes in sedentary behavior among adolescent girls: a 2.5-year prospective cohort study. J Adolesc Health 2007;40(2):158-65.
27. Nilsson A, Andersen LB, Ommundsen Y, Froberg K, Sardinha LB, Piehl-Aulin K, et al. Correlates of objectively assessed physical activity and sedentary time in children: a cross-sectional study (The European Youth Heart Study). BMC Public Health 2009;9:322.
28. Ibabe I, Albertos A, Lopez-Del Burgo C. Leisure time activities in adolescents predict problematic technology use. Eur Child Adolesc Psychiatry 2024;33(1):279-89.
29. Galindo-Perdomo F, Peiró-Velert C, Valencia-Peris A. Do adolescents who meet physical activity recommendations on weekdays also meet them on weekends? A cross-sectional study in Colombia. Int J Environ Res Public Health 2021;18(3):897.
30. Pearson N, Biddle SJ. Sedentary behavior and dietary intake in children, adolescents, and adults. A systematic review. Am J Prev Med 2011;41(2):178-88.
31. Subiron-Valera AB, Rodriguez-Roca B, Calatayud E, Gomez-Soria I, Andrade-Gómez E, Marcen-Roman Y. Linking sedentary behavior and mental distress in higher education: a cross-sectional study. Front Psychol 2023;14:1205837.
32. Tice DM, Bratslavsky E, Baumeister RF. Emotional distress regulation takes precedence over impulse control: if you feel bad, do it! J Pers Soc Psychol 2001;80(1):53-67.
33. Bounova A, Michalopoulou M, Agelousis N, Kourtessis T, Gourgoulis V. The parental role in adolescent screen related sedentary behavior. Int J Adolesc Med Health 2016;30(2):20160031.

Original Article

Korean J Health Promot 2025;25(4):138-146
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00185

Korean Journal of Health Promotion
KJHP

The Association between Self-Rated Health and Body Weight Image among Korean Adolescents

Yoonsoo SUNG, MD, Jung Ah LEE, MD, PhD, and Sung SUNWOO, MD, PhD

Department of Family Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

ABSTRACT

Background: Self-rated health (SRH) is crucial for predicting morbidity and mortality across age groups, including adolescents and adults. Body image dissatisfaction, measured by difference between current and ideal weight, surpasses body mass index (BMI) in predicting health outcomes. We evaluated the correlation between body image perception and SRH among middle and high school students in Korea.

Methods: This study comprised of 51,850 students aged 12–18 years who participated in the 2022 Korea Youth Risk Behavior Survey. Subjective health status was categorized into 'good' or 'poor' groups. Body image was classified into 'underweight,' 'normal,' or 'overweight.' BMI was determined using age-specific percentiles: underweight (<5th percentiles), overweight (85th–95th percentiles), and obese (>95th percentiles). Data analysis was performed by multivariable logistic analysis and adjusted for depressive mood, stress, and socioeconomic status.

Results: The total participants (N=50,455) included 59.4% with normal weight according to BMI, only 36.4% perceived themselves as normal. Students who perceived themselves as having a normal weight had higher rates of good SRH compared to others. Excluding females with BMI ≥25 kg/m^2, both sex showed higher odds ratios [ORs] for poor SRH when perceiving themselves overweight (male: OR=2.57, 95% confidence interval [95% CI]=2.367–2.782; female: OR=1.36, 95% CI=1.270–1.452) or underweight (male: OR=1.64, 95% CI=1.507–1.791; female: OR=1.36, 95% CI=1.256–1.472).

Conclusions: More than half of the students responded negatively to their body image, associated with poor subjective health status. Therefore, promoting accurate body weight perceptions will play a positive role in overall health of adolescents.

Keywords: Diagnostic self evaluation, Body image, Body dissatisfaction, Body mass index

INTRODUCTION

The World Health Organization (WHO) defines health as a state of complete physical, mental, and social well-being, emphasizing the health is not merely the absence of disease. Currently, the concept of health is generally regarded as encompassing both physical and psychological dimensions [1]. Self-rated health (SRH) is a self-reported health measure that evaluates an individual's integrated perception of health, which is inaccessible to external observers [2-4]. Despite its inherently subjective nature, SRH provides a systematic assessment of health across biological, psychological, and social domains and can reflect overall health more sensitively than external measurements. Furthermore, it demonstrates strong predictive validity for mor-

Received: September 30, 2025; **Revised:** November 3, 2025; **Accepted:** November 3, 2025
Corresponding author: Sung SUNWOO, MD, PhD
Department of Family Medicine, Asan Medical Center, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea
Tel: +82-2-3010-3952 Fax: +82-2-3010-3815 E-mail: sws@amc.seoul.kr

bidity and mortality and has therefore been widely used since the 1950s to assess population health status [5].

Adolescence is a critical developmental period characterized by rapid physical changes and heightened self-consciousness regarding body image. During this stage, how adolescents perceive their body shape—whether they consider themselves underweight, normal, or overweight—can strongly influence their psychological well-being and health perception [6]. Body image dissatisfaction and weight misperception are prevalent among adolescents and are known to contribute to depressive symptoms, low self-esteem, and disordered eating behaviors [7,8]. In particular, several studies among Korean adolescents have reported significant associations between self-perceived weight and SRH, suggesting that subjective body perception may play a critical role in adolescents' health evaluation [8,9].

Previous studies have suggested that subjective perceptions of body weight may be more closely related to SRH than objective measures such as body mass index (BMI) [9]. For instance, adolescents who perceive themselves as overweight or underweight then report poorer SRH regardless of their actual BMI. This implies that subjective body image may serve as a psychosocial determinant of perceived health that operates independently of objective body weight.

Body image dissatisfaction arises from psychological and emotional factors, social norms, and distorted body perceptions [10]. It begins after the preschool years, when children begin to recognize their body shape, peaks during adolescence due to rapid physical changes, and remains relatively stable in adulthood [11]. In the 2010 Korea Youth Risk Behavior Web-based Survey (KYRBS), 19.3% of adolescents who attempted weight loss reported using inappropriate methods, indicating that a considerable proportion of Korean adolescents have long perceived their body shape in a biased manner [11].

Given the increasing prevalence of body image distortion and its potential impact on adolescents' mental and physical health [12,13], it is crucial to understand how perceived body image relates to SRH. Using data from the 2022 KYRBS, this study aimed to examine the association between adolescents' subjective body image perception and their SRH status.

METHODS

Study participants

This study used data from the 2022 KYRBS, conducted by the Korea Disease Control and Prevention Agency between August 29 and October 25, 2022. The KYRBS is an annual, nationwide survey of students from the first year of middle school to the third year of high school. The sampling process involves stratification of the target population, sample allocation, and multistage cluster sampling. For the 2022 survey, 17 provinces and metropolitan cities were stratified into 539 regional clusters. Schools were selected to achieve a 50:50 ratio between middle and high schools, resulting in a total of 800 sample schools nationwide. Ultimately, 51,850 students from grades 7 to 12 participated in the survey. After excluding 1,395 students who did not report their height and weight, making BMI calculation impossible, 50,455 participants were included in the final analysis. There were no participants with missing responses for SRH or perceived body image.

Study variables and definitions

BMI was calculated using self-reported height and weight. In adolescents, BMI is interpreted based on age- and sex-specific growth charts rather than adult cutoffs. According to the WHO, obesity is defined as a BMI ≥2 standard deviations above the median for age and sex [14]. In Korea, the 2017 Korean National Growth Charts classify underweight as a BMI below the 5th percentile, overweight as a BMI between the 85th and 95th percentiles, and obesity as a BMI at or above the 95th percentile for age and sex [15]. Since 2017 Korean National Growth Charts reflect population-specific growth patterns and percentile cutoffs that better represent Korean adolescents than the WHO reference, these criteria were adopted in this study. Participants were categorized into four groups: underweight, normal weight, overweight, and obese.

Perceived body image was assessed through the question, "How do you perceive your body shape?" Responses of "very thin" and "somewhat thin" were classified as underweight perception; "normal" as normal perception; and "somewhat fat" and "very fat" as overweight perception. SRH was assessed with the question, "How would you describe your usual health status?" Responses of "very healthy" and "healthy" were classified as good, while "fair," "unhealthy" and "very unhealthy" were classified as poor. Stress was assessed using the question, "How much stress do you usually feel?" Responses of "very much" and "much" were categorized as high stress, while "some," "little," and "none" were categorized as low stress. Depressive symptoms were identified by using the question. "During the past 12 months, have you ever felt so sad or hopeless almost every day for 2 consecutive weeks or more that you stopped doing some usual activities?" Responses were categorized as yes or no. Socioeconomic status (SES) was determined by the question, "What is your family's economic status?" Responses were "high" and "middle-high" were classified as high SES. "Middle" as middle SES, and "middle-low" and "low" as low SES.

Statistical analysis

All analyses were performed using SPSS Statistics version 27.0 (IBM Crop.). Descriptive statistics, including frequencies and percentages, were calculated for perceived body image and BMI categories. Chi-square tests were used to examine the association between each variable and SRH. Multivariable logistic regression analyses were then conducted to assess the association between perceived body image and SRH while adjusting for depressive symptoms stress level, and SES. Statistical significance was determined using two-sided *P*-values <0.05.

Ethics approval

This study used data from the KYRBS, which are publicly available and fully deidentified. Therefore, institutional review board review and informed consent were not required in accordance with national regulations.

RESULTS

General characteristics of the study participants

Table 1 presents the general characteristics of the study participants. Among the total sample 25,751 (51.7%) were male and

Table 1. Basic characteristics of participants

Variable	Total (n)	Self-rated health		*P*-value
		Good	Poor	
Age (yr)	50,455			<0.001
12	2,319	1,658 (71.2)	661 (28.8)	
13	9,029	6,192 (68.8)	2,837 (31.2)	
14	9,242	6,005 (64.9)	3,237 (35.1)	
15	8,889	5,614 (63.3)	3,275 (36.7)	
16	8,091	4,960 (61.3)	3,131 (38.7)	
17	7,561	4,671 (61.3)	2,890 (38.7)	
18	5,324	3,133 (58.2)	2,191 (41.8)	
Sex	50,455			<0.001
Male	25,751	17,746 (68.6)	8,005 (31.4)	
Female	24,704	14,487 (58.1)	10,217 (41.9)	
School	50,455			<0.001
Middle school	27,310	18,147 (66.5)	9,163 (33.5)	
High school	23,145	14,086 (60.5)	9,059 (39.5)	
Economic status of family	50,453			<0.001
High	21,345	15,112 (70.2)	6,233 (29.8)	
Middle	23,575	14,280 (60.2)	9,295 (39.8)	
Low	5,533	2,839 (51.0)	2,694 (49.0)	
Perceived body image	50,455			<0.001
Underweight	13,506	8,665 (63.8)	4,841 (36.2)	
Normal weight	18,407	13,034 (70.5)	5,373 (29.5)	
Overweight	18,542	10,534 (56.3)	8,008 (43.7)	
Stress perception	50,455			<0.001
None to mild	29,759	21,661 (72.4)	8,098 (27.6)	
Moderate to severe	20,696	10,572 (50.9)	10,124 (49.1)	
Depressed for at least 2 weeks in a year	50,455			<0.001
No	35,963	24,531 (67.9)	11,432 (32.1)	
Yes	14,492	7,702 (52.9)	6,790 (47.1)	
BMI	50,455			<0.001
BMI<5th percentile	4,416	2,475 (55.9)	1,941 (44.1)	
5th percentile≤BMI<85th percentile	34,971	23,484 (66.8)	11,487 (33.2)	
85th percentile≤BMI<95th percentile	4,694	2,933 (62.4)	1,761 (37.6)	
BMI≥95th percentile	6,374	3,341 (51.4)	3,033 (48.6)	

Values are presented as number only or number (%). All percentages were calculated using survey weights to account for the complex sampling design of the Korea National Health and Nutrition Examination Survey. Therefore, the weighted percentages may not correspond exactly to the crude proportions calculated from the raw sample counts. *P*-value by chi-square test for categorical variable.
BMI, body mass index.

24,702 (48.3%) were female. The proportion of adolescents reporting poor SRH was significantly higher among females (10,217 [41.9%]) than males (8,005 [31.4%]). Based on BMI, 4,416 participants (9.0%) were underweight, 34,971 (69.7%) were normal weight, 4,694 (0.15) were overweight, and 6,374 (12.2%) were obese.

In terms of perceived body image, 13,506 participants (27.2%) considered themselves underweight, 18,407 (36.7%) normal, and 18,542 (36.2%) overweight. The proportion reporting poor SRH was 36.2% among those perceiving themselves as underweight, 29.5% among those perceiving normal weight, and 43.7% among those perceiving overweight, with the highest prevalence in the overweight perception group.

Depressive symptoms were reported by 14,492 participants (28.6%), while 35,962 (71.4%) reported no depressive symptoms. The prevalence of poor SRH was significantly higher among those with depressive symptoms.

SES also showed a clear gradient: 21,345 participants (43.4%) reported high SES, 23,575 (46.2%) middles SES, and 5,533 (10.4%) low SES. The proportion with poor SRH rose steadily across these groups: 29.8%, 39.8%, and 49.0%, respectively (*P*<0.001).

Self-reported body image and body mass index in relation to self-rated health

As shown in Table 2, among the 50,455 participants, 6,374 (12.2%) were obese by BMI, but 18,542 (36.2%) perceived themselves as obese—roughly three times the actual prevalence.

Among adolescents classified as underweight by BMI, most (4,001 [90.6%]) perceived themselves as underweight, while 8.3% (365 participants) saw themselves as normal and 1.1% (50 participants) as overweight. Across these groups, 40%–50% reported poor SRH.

Among those with a normal BMI, 27.2% (9,471 participants) perceived themselves as underweight, 49.5% (17,307 participants) as normal, and 23.3% (8,193 participants) as overweight. The prevalence of poor SRH was 32.7%, 29.3%, and 41.9% respectively; adolescents perceiving themselves as underweight or overweight showed significantly higher rates compared with those perceiving normal weight (*P*<0.001).

Similar patterns appeared in the overweight and obese BMI groups (*P*<0.001 and *P*=0.006, respectively). Except for the underweight BMI group, adolescents with weight misperception, perceiving themselves as underweight or overweight when their BMI was normal, consistently reported poor SRH more often

Table 2. Self-rated health according to perceived body image and actual BMI

Actual BMI	Perceived body image	Total (n)	Self-rated health		*P*-value
			Good	Poor	
Total	Total	50,455			<0.001
	Underweight	13,506	8,665 (63.8)	4,841 (36.2)	
	Normal weight	18,407	13,034 (70.5)	5,373 (29.5)	
	Overweight	18,542	10,534 (56.3)	8,008 (43.7)	
Underweight (BMI<5th percentage)	Total	4,416			0.484
	Underweight	4,001	2,243 (55.8)	1,758 (44.2)	
	Normal weight	365	210 (58.1)	155 (41.9)	
	Overweight	50	22 (48.7)	28 (51.3)	
Normal (5th percentage≤BMI<85th percentage)	Total	34,971			<0.001
	Underweight	9,471	6,398 (67.3)	3,073 (32.7)	
	Normal weight	17,307	12,285 (70.7)	5,022 (29.3)	
	Overweight	8,193	4,801 (58.1)	3,392 (41.9)	
Overweight (85th percentage≤BMI<95th percentage)	Total	4,694			<0.001
	Underweight	11	9 (73.3)	2 (26.7)	
	Normal weight	549	422 (76.7)	127 (23.3)	
	Overweight	4,134	2,502 (60.5)	1,632 (39.5)	
Obesity (95th percentage≤BMI)	Total	6,374			0.006
	Underweight	23	15 (52.7)	8 (47.3)	
	Normal weight	186	117 (63.2)	69 (36.8)	
	Overweight	6,165	3,209 (51.0)	2,956 (49.0)	

Values are presented as number only or number (%). All percentages were calculated using survey weights to account for the complex sampling design of the Korea National Health and Nutrition Examination Survey. Therefore, the weighted percentages may not correspond exactly to the crude proportions calculated from the raw sample counts. *P*-value by chi-square test for categorical variable.
BMI, body mass index.

than those with accurate weight perception.

Sex-specific associations between body image perception and self-rated health

Male adolescents

Among male adolescents, those with a body image perception other than normal had higher odds of reporting poor SRH compared with those perceived themselves as normal (Table 3). After adjusting for depressive symptoms, stress level, and SES, the odds of reporting poor SRH remained significantly elevated: odds ratio (OR)=1.64 (95% confidence interval [95% CI]=1.51–1.79) for those perceiving themselves as underweight and OR=2.57 (95% CI=2.37–2.78) for those perceiving themselves as overweight.

Within the subgroup of males with a normal BMI, adolescents perceiving themselves as underweight or overweight showed significantly greater odds of poor SRH compared with those perceiving normal weight. ORs that were unstable or approached zero were reported as "NA" (not applicable).

Female adolescents

Findings among female adolescents were like those in males (Table 4). After adjustment for depressive symptoms, stress level, and SES, the odds of reporting poor SRH were significantly higher in those perceiving themselves as underweight (OR=1.36, 95% CI=1.26–1.47) and those perceiving themselves as overweight (OR=1.36, 95% CI=1.27–1.45) compared with those perceiving normal weight.

Among females with a normal BMI, perceiving oneself as underweight or overweight was also associated with significantly increased odds of poor SRH compared with perceiving normal weight.

DISCUSSION

In this nationally representative sample of Korean adolescents, those who perceived their body image as underweight or overweight had higher odds of reporting poor SRH compared with those who perceived their body image as normal. This association remained significant in both boys and girls, even among adolescents with a normal BMI, indicating that subjective body image perception influences perceived health independently of

Table 3. Association between perceived body image and SRH among boys

Perceived body image	Model 1[a] (poor SRH)		Model 2[b] (poor SRH)		Model 3[c] (poor SRH)	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Total						
Underweight	1.71 (1.57–1.86)	<0.001	1.66 (1.53–1.81)	<0.001	1.64 (1.51–1.79)	<0.001
Normal weight	1		1		1	
Overweight	2.65 (2.45–2.86)	<0.001	2.59 (2.39–2.81)	<0.001	2.57 (2.37–2.78)	<0.001
BMI<5th percentage						
Underweight	1.08 (0.68–1.72)	0.734	1.00 (0.61–1.64)	0.998	0.99 (0.61–1.62)	0.969
Normal weight	1		1		1	
Overweight	2.06 (0.67–6.33)	0.207	1.64 (0.52–5.21)	0.400	1.73 (0.48–6.16)	0.401
5th percentage≤BMI<85th percentage						
Underweight	1.53 (1.39–1.68)	<0.001	1.48 (1.35–1.63)	<0.001	1.46 (1.33–1.61)	<0.001
Normal weight	1		1		1	
Overweight	2.24 (2.02–2.49)	<0.001	2.18 (1.96–2.43)	<0.001	2.17 (1.94–2.42)	<0.001
85th percentage≤BMI<95th percentage						
Underweight	NA		NA		NA	
Normal weight	1		1		1	
Overweight	2.22 (1.68–2.95)	<0.001	2.25 (1.69–3.00)	<0.001	2.23 (1.67–2.97)	<0.001
95th percentage≤BMI						
Underweight	1.86 (0.68–5.07)	0.226	1.83 (0.70–4.80)	0.219	1.85 (0.71–4.81)	0.205
Normal weight	1		1		1	
Overweight	1.78 (1.23–2.59)	0.003	1.80 (1.22–2.66)	0.003	1.81 (1.22–2.67)	0.003

OR and 95% CI were estimated using multiple logistic regression analysis with complex samples. Perceived body image categories (underweight, normal, overweight) are nested within each actual BMI group.
BMI, body mass index; CI, confidence interval; NA, not applicable; OR, odds ratio; SRH, self-rated health.
[a]Univariate analysis; [b]Adjusted for depressive mood and stress; [c]Adjusted for depressive mood, stress, and economic status of family.

Table 4. Association between perceived body image and SRH among girls

Perceived body image	Model 1[a] (poor SRH)		Model 2[b] (poor SRH)		Model 3[c] (poor SRH)	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Total						
Underweight	1.36 (1.26–1.47)	<0.001	1.33 (1.23–1.44)	<0.001	1.36 (1.26–1.47)	<0.001
Normal weight	1		1		1	
Overweight	1.52 (1.42–1.62)	<0.001	1.411 (1.32–1.51)	<0.001	1.36 (1.27–1.45)	<0.001
BMI<5th percentage						
Underweight	1.20 (0.91–1.58)	0.207	1.14 (0.85–1.54)	0.374	1.15 (0.86–1.54)	0.350
Normal weight	1		1		1	
Overweight	1.25 (0.56–2.81)	0.587	0.93 (0.39–2.21)	0.868	0.83 (0.34–2.00)	0.676
5th percentage≤BMI<85th percentage						
Underweight	1.25 (1.14–1.37)	<0.001	1.22 (1.11–1.34)	<0.001	1.25 (1.13–1.37)	<0.001
Normal weight	1		1		1	
Overweight	1.46 (1.36–1.58)	<0.001	1.35 (1.25–1.46)	<0.001	1.31 (1.21–1.41)	<0.001
85th percentage≤BMI<95th percentage						
Underweight	5.96 (0.45–78.67)	0.175	5.91 (0.44–79.23)	5.913	8.00 (0.60–107.18)	0.116
Normal weight	1		1		1	
Overweight	1.65 (1.11–2.43)	0.013	1.52 (1.02–2.29)	0.042	1.46 (0.96–2.20)	0.075
95th percentage≤BMI						
Underweight	NA		NA		NA	
Normal weight	1		1		1	
Overweight	1.23 (0.64–2.35)	0.532	1.13 (0.58–2.20)	0.712	1.06 (0.55–2.02)	0.869

OR and 95% CI were estimated using multiple logistic regression analysis with complex samples.
BMI, body mass index; CI, confidence interval; NA, not applicable; OR, odds ratio; SRH, self-rated health.
[a]Univariate analysis; [b]Adjusted for depressive mood and stress; [c]Adjusted for depressive mood, stress, and economic status of family.

objective weight status.

These findings suggest that adolescents' self-perceived body image functions as a psychosocial determinant of perceived health, rather than merely reflecting objective BMI. Whereas BMI represents a physiological indicator of adiposity, perceived body image encompasses psychosocial and sociocultural dimensions of how individuals evaluate their own bodies. Therefore, the observed association between distorted body image and poor SRH highlights the importance of addressing the cognitive and emotional components of health beyond objective anthropometric measures. Taken together, our results indicate that subjective body image may outweigh BMI as a predictor of SRH [9], underscoring the need for public health strategies that target adolescents' perceptions and attitudes toward their bodies, rather than focusing solely on physical weight status.

This study is meaningful in that it examined the relationship between body image perception and SRH using large-scale, nationally representative data. SRH is known to be one of the strongest predictors of healthcare utilization, medical costs, and mortality, and poor SRH in adolescence has been reported to influence health outcomes in adulthood [16,17].

Our findings are consistent with previous research conducted in young, middle-aged, and general adult populations, which also demonstrated that inaccurate or dissatisfied body image is associated with worse SRH [18-20]. This study extends these findings to Korean adolescents.

Some subgroups showed limited associations, largely due to very small sample sizes. For example, among boys who were overweight by BMI but perceived themselves as underweight, and among girls who were obese by BMI but perceived themselves as underweight, the association between body image perception and SRH was weak or absent. However, these groups contained only a negligible number of participants, making reliable interpretation difficult. The associations between perceived body image and SRH were most evident among adolescents with normal BMI for both sexes (Table 2–4). This pattern may be explained by the substantially larger sample size in this group, which provided greater statistical power to detect differences. In contrast, subgroups showing the largest discrepancies between actual BMI and perceived weight—such as underweight adolescents perceiving themselves as overweight or obese adolescents perceiving themselves as underweight—did not exhibit significant associations. These non-significant findings may be attributed to the small number of participants and wide confidence intervals, suggesting limited precision rather than a true lack of association. Alternatively, adolescents in these extreme mismatch groups may have developed psychological adaptation or denial mechanisms that buffer the perceived impact on SRH [21,22]. Future studies with larger samples or longitudinal designs are warranted to clarify whether these results reflect limited power or genuine null relationships.

Beyond SRH, body image perception has been linked to broader aspects of mental well-being. Previous studies have reported positive correlations between body satisfaction and self-esteem in both sexes, while adolescents with distorted body images are more likely to engage in weight-control behaviors and exhibit higher rates of depression and suicidal ideation [23,24].

One potential mechanism underlying these associations is identity confusion, in which negative early-life experiences contribute to fragile self-identity and internalization or unrealistic ideals, leading to dissatisfaction [25]. Additionally, increased exposure to manipulated images through social networking services (SNS) may promote upward social comparison and negative body image [26]. Further research is warranted to clarify the determinants of body image formation during adolescence. In addition, future research should employ longitudinal designs to elucidate causal pathways between body image perception and SRH, and explore potential mediating factors such as self-esteem, social comparison, and media exposure. Studies integrating both psychological and behavioral dimensions may help develop more effective interventions for improving adolescents' body image and perceived health.

Interventions aimed at improving body image and strengthening self-identity may help adolescents develop a more positive perception of their bodies. Since poor SRH was observed even among adolescents with normal BMI when body image perception was inaccurate, reliance on BMI alone is insufficient for assessing adolescents' health. Educational programs that foster a positive body image have been shown to buffer the negative effects of idealized media portrayals [27]. Even peer-delivered programs, such as those conducted by university students, have been shown to reduce body dissatisfaction among adolescents [28]. Internationally, several initiatives address body image concerns—for instance, the United Kingdom's All-Party Parliamentary Group on Body Image has proposed national policies [29], and the Dove Self-Esteem Project with its "Confident Me" has been implemented globally to promote positive body image among youth [30,31].

This study has several limitations. First, BMI was calculated from self-reported height and weight, which may introduce measurement error. Second, because this was a cross-sectional analysis, causality between body image perception and SRH cannot be established.

Conclusion

This study evaluated SRH according to body image perception among Korean adolescents and found that inaccurate or dissatisfied body image was associated with poor SRH. Given the long-term impact of adolescents' SRH on adulthood, effective strategies to promote accurate and positive body image in youth are needed.

ORCID

Yoonsoo SUNG, https://orcid.org/0009-0003-5688-4589
Jung Ah LEE, https://orcid.org/0000-0003-3125-7805
Sung SUNWOO, https://orcid.org/0000-0002-0521-4804

AUTHOR CONTRIBUTIONS

Dr. Sung SUNWOO had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: JAL. Data curation: JAL. Formal analysis: YS. Methodology: JAL. Project administration: SS. Resources: JAL. Supervision: JAL and SS. Validation: YS. Writing–review & editing: all authors.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

FUNDING

None.

DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

REFERENCES

1. World Health Organization (WHO). Constitution [Internet].

WHO; 2025 [cited Sep 29, 2025]. Available from: https://www.who.int/about/governance/constitution
2. Miilunpalo S, Vuori I, Oja P, Pasanen M, Urponen H. Self-rated health status as a health measure: the predictive value of self-reported health status on the use of physician services and on mortality in the working-age population. J Clin Epidemiol 1997;50(5):517-28.
3. Han MA, Kim KS, Park J, Kang MG, Ryu SY. Association between levels of physical activity and poor self-rated health in Korean adults: The Third Korea National Health and Nutrition Examination Survey (KNHANES), 2005. Public Health 2009;123(10):665-9.
4. Badawi G, Gariépy G, Pagé V, Schmitz N. Indicators of self-rated health in the Canadian population with diabetes. Diabet Med 2012;29(8):1021-8.
5. De Oliveira da Silva P, Miguez Nery Guimarães J, Härter Griep R, Caetano Prates Melo E, Maria Alvim Matos S, Del Carmem Molina M, et al. Association between body image dissatisfaction and self-rated health, as mediated by physical activity and eating habits: structural equation modelling in ELSA-Brasil. Int J Environ Res Public Health 2018;15(4):790.
6. Mäkinen M, Puukko-Viertomies LR, Lindberg N, Siimes MA, Aalberg V. Body dissatisfaction and body mass in girls and boys transitioning from early to mid-adolescence: additional role of self-esteem and eating habits. BMC Psychiatry 2012;12:35.
7. Ha Y, Chae Y. Impact of body image on depressive symptoms of adolescents: mediating effect of self-perception. J Korean Soc Sch Health 2019;32(1):50-8.
8. Oh J, Mun WL, Lee YE, Roh SY, Kim G. Interrelation between BMI, dietary habits, self-rated health, and body image perception among Korean adolescents: the Korea Youth Risk Behavior Web-Based Survey (2022). Nutrients 2025;17(2):253.
9. Lee K. Self-perceived weight and self-rated health have distinct relationships according to body mass index in Korean teenagers. Nutr Res 2022;107:179-86.
10. Cash TF. Encyclopedia of body image and human appearance. Academic Press; 2012.
11. Lee YJ, Lee SJ, Kim CG. Korean adolescents' weight control behaviors by BMI (Body Mass Index) and body shape perception: Korea Youth Risk Behavior web-based Survey from 2010. J Digit Converg 2012;10(3):227-32.
12. Gonzaga I, Ribovski M, Claumann GS, Folle A, Beltrame TS, Laus MF, et al. Secular trends in body image dissatisfaction and associated factors among adolescents (2007-2017/2018). PLoS One 2023;18(1):e0280520.
13. Hong SC, Jung YE, Kim MD, Lee CI, Hyun MY, Bahk WM, et al. Prevalence of distorted body image in young Koreans and its association with age, sex, body weight status, and disordered eating behaviors. Neuropsychiatr Dis Treat 2015;11:1043-9.
14. World Health Organization (WHO). BMI-for-age (5-19 years) [Internet]. WHO; 2023 [cited Sep 29, 2025]. Available from: https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators/bmi-for-age
15. Korea Disease Control and Prevention Agency (KDCA). Childhood obesity: causes and management [Internet]. KDCA; 2023 [cited Sep 29, 2025]. Available from: https://health.kdca.go.kr/healthinfo/biz/health/gnrlzHealthInfo/gnrlzHealthInfo/gnrlzHealthInfoView.do?cntnts_sn=5213
16. Hetlevik Ø, Vie TL, Meland E, Breidablik HJ, Jahanlu D. Adolescent self-rated health predicts general practice attendance in adulthood: results from the Young-HUNT1 survey. Scand J Public Health 2019;47(1):37-44.
17. Vingilis ER, Wade TJ, Seeley JS. Predictors of adolescent self-rated health. Analysis of the National Population Health Survey. Can J Public Health 2002;93(3):193-7.
18. Herman KM, Hopman WM, Rosenberg MW. Self-rated health and life satisfaction among Canadian adults: associations of perceived weight status versus BMI. Qual Life Res 2013;22(10):2693-705.
19. Kwon S. Body mass index, perceived weight, and self-rated health among South Korean adults: conjoint effect on health? AIMS Public Health 2017;4(5):513-25.
20. Yoon SJ, Jung JG, Ahn SK, Kim JS, Hong JH. Non-linear relationship between body mass index and self-rated health in older Korean adults: body image and sex considerations. Epidemiol Health 2023;45:e2023061.
21. Markey CN. Invited commentary: why body image is important to adolescent development. J Youth Adolesc 2010;39(12):1387-91.
22. Franzoi SL, Shields SA. The Body Esteem Scale: multidimensional structure and sex differences in a college population. J Pers Assess 1984;48(2):173-8.
23. Lee J, Lee Y. The association of body image distortion with weight control behaviors, diet behaviors, physical activity, sadness, and suicidal ideation among Korean high school students: a cross-sectional study. BMC Public Health 2016;16:39.
24. Hyun MY, Jung YE, Kim MD, Kwak YS, Hong SC, Bahk WM, et al. Factors associated with body image distortion in Korean adolescents. Neuropsychiatr Dis Treat 2014;10:797-802.
25. Vankerckhoven L, Raemen L, Claes L, Eggermont S, Palmeroni

N, Luyckx K. Identity formation, body image, and body-related symptoms: developmental trajectories and associations throughout adolescence. J Youth Adolesc 2023;52(3):651-69.
26. Mun JY, Han SY. The effects of Instagram viewing activity, body comparison, and body satisfaction on self-esteem of female undergraduate students. Korean J Dev Psychol 2019;32(3):61-78.
27. Andrew R, Tiggemann M, Clark L. Can body appreciation protect against media-induced body dissatisfaction? J Eat Disord 2015;3(Suppl 1):O19.
28. Halliwell E, Jarman H, McNamara A, Risdon H, Jankowski G. Dissemination of evidence-based body image interventions: a pilot study into the effectiveness of using undergraduate students as interventionists in secondary schools. Body Image 2015;14:1-4.
29. U.K. Parliamentary. Register of all-party parliamentary groups [as at 30 July 2015] [Internet]. U.K. Parliamentary; 2023 [cited Sep 29, 2025]. Available from: https://publications.parliament.uk/pa/cm/cmallparty/register/body-image.htm
30. Diedrichs PC, Atkinson MJ, Garbett KM, Leckie G. Evaluating the "Dove Confident Me" five-session body image intervention delivered by teachers in schools: a cluster randomized controlled effectiveness trial. J Adolesc Health 2021;68(2):331-41.
31. Unilever. Dove self-esteem project [Internet]. Unilever; 2025 [cited Sep 29, 2025]. Available from: https://www.dove.com/au/dove-self-esteem-project.html

Original Article

Korean J Health Promot 2025;25(4):147-154
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00178

Korean Journal of Health Promotion
KJHP

Associations of Alcohol Drinking with Chronic Diseases among Korean Men with Severe Vision Disorders

Sunmee YUN-WELCH, PhD[1], Sunhee KIM, PhD[2], Jeehoon LEE[2], Mieun YUN, PhD[2,3], Geumseon LEE, PhD [2,4]

[1]White Cane Independent Living Support Center for the Impaired, Seoul, Korea
[2]Department of Addiction Science, Graduate School, Sahmyook University, Seoul, Korea
[3]Department of Food and Nutrition, Sahmyook University, Seoul, Korea
[4]SW Convergence Education Institute Sahmyook University, Seoul, Korea

ABSTRACT

Background: Visually impaired individuals have a higher prevalence of chronic diseases compared with the general Korean population. However, little is known about the associations between alcohol drinking and chronic diseases in this population. This study aimed to examine these associations among severe vision disorders among adult men.

Methods: A total of 237 men severely visually impaired adults aged 50 years or older were surveyed. Alcohol use was assessed using the Alcohol Use Disorders Identification Test–Korean version. Logistic regression analyses were performed to identify associations between alcohol drinking behaviors and chronic diseases, adjusting for age, body mass index, education level, economic activity, physical activity, regular diet habits and smoking.

Results: Hypertension was the most common condition (22.8%), followed by liver disease (16.6%) and diabetes mellitus (16.2%). Other reported conditions included osteoarthritis (9.0%), pneumonia (8.4%), kidney disease (8.2%), heart disease (5.7%), cerebrovascular disease (5.7%), cancer (4.5%), and gout (3.1%). Only 11.8% of participants reported no chronic conditions, while 22.4% had one and 28.3% had two. Multimorbidity (≥3 conditions) was observed in 37.6% of participants, with 7.2% reporting five or more conditions. Past drinkers/non-drinkers showed a significantly lower odds of heart disease (P=0.006) and pneumonia (P=0.011). In contrast, arthritis showed a significantly higher risk among current drinkers (P=0.039). Hazardous drinkers (Alcohol Use Disorders Identification Test–Korean version score≥8) showed a higher prevalence of cancer (P=0.023) and liver disease (P=0.024) compared with non-hazardous drinkers. Hazardous drinking was associated with 9.00-fold increased risk of diabetes (95% confidence interval=1.68–48.14, P<0.05).

Conclusions: Hazardous drinking showed 9.00-fold increased risk of diabetes among adults with severe visual impairment. Tailored health promotion programs are needed to address alcohol drinking behaviors and prevent chronic diseases in this population.

Keywords: Vision disorders, Alcohol drinking, Chronic disease, Health behavior, Alcoholism

INTRODUCTION

Visually impaired individuals experience higher rates of chronic disease than those without disabilities. According to the 2020 national survey on persons with disabilities in Korea, the prevalence of hypertension among visually impaired individuals was

Received: September 30, 2025; **Revised:** November 12, 2025; **Accepted:** November 21, 2025
Corresponding author: Geumseon LEE, PhD
Department of Addiction Science, Graduate School, Sahmyook University, 815 Hwarang-ro, Nowon-gu, Seoul 01795, Korea
Tel: +82-2-3399-3696 Fax: +82-2-3399-3634 E-mail: sue7179@syu.ac.kr

43.7%, nearly three times that in the general population (14.8%). Similarly, diabetes prevalence was more than double (25.0% vs. 9.7%) [1]. Such disparities cannot be explained by biological factors alone; they are likely influenced by restricted living environments, limited healthcare access, and unique health behaviors. Global surveillance reports, including World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) data, have consistently documented similar disparities in health outcomes among visually impaired populations [2-4]. Prior research has also confirmed that vision disorders is strongly associated with reduced healthcare utilization and delayed access to treatment, underscoring systemic barriers for visually impaired individuals [5]. In Korea, epidemiological studies have reported a notable prevalence of alcoholism and their health-related consequences [6].

Alcohol drinking is a well-established risk behavior associated with cardiovascular disease, diabetes, respiratory illness, and cancer. Epidemiological evidence has also shown that blindness is correlated with systemic diseases such as diabetes and renal dysfunction, highlighting the intersection of visual impairment and chronic illness [7]. However, previous research on people with disabilities has largely focused on general health behaviors, healthcare access, and quality of life, with few empirical studies specifically addressing the relationship between alcohol drinking and chronic diseases in visually impaired populations. U.S. data also indicate that adults with vision disorders face significant barriers to healthcare access and utilization [8]. Furthermore, problem drinking among people with disabilities has been shown to increase the risk of chronic diseases, underscoring the importance of targeted investigations [9].

This study therefore seeks to analyze the associations between alcohol drinking behaviors and chronic disease diagnoses among men with severe vision disorders aged 50 years or older, providing foundational evidence for developing tailored health promotion strategies. National reviews have emphasized the need for preventive policies focused on alcoholism in Korea, further supporting the rationale for this study [10]. Recent national statistics also highlight persistent health inequities among people with disabilities, reinforcing the urgency of evidence-based interventions [11-13]. This subgroup focus is further justified by evidence that older adults with both diabetes and vision disorders face heightened risks of malnutrition and chronic disease, highlighting the vulnerability of this population [14].

METHODS

Participants

This study included 237 men aged 50 years and older with severe vision disorders who were officially registered as persons with disabilities in Korea and held disability welfare card. Participants were recruited from the alumni associations member's list of blind schools and vocational training centers for visually impaired nationwide. Also from the blind churches. We telephoned 450 visually impaired people, There were 46 cases (10.2%) where the phone ringtone was not received, 15 cases (3.3%) where the number did not exist or was changed to someone else's name, and 32 cases (7.1) where the call was made but the person was under 50 years old or had mild vision disorders and thus did not meet the study criteria and 54 cases (12.0%) of them refused to participate in the survey, because the burden of the survey or recording, inconvenience to their family, or lack of time.

The minimum required sample size was calculated using G*Power software, assuming a medium effect size, α=0.05, and a 95% confidence level, resulting in 287 participants. To ensure sufficient power, the final target sample was set at 303.

This study was approved by the Institutional Review Board of Sahmyook University (IRB No. SYU 2023-02-015-002). Verbal informed consent was obtained from all participants by telephone prior to data collection, and the process was recorded. Confidentiality and anonymity were strictly maintained; no personally identifiable information was collected, and all analyses were performed on de-identified data.

Measures

Alcohol use

Measured using the Alcohol Use Disorders Identification Test–Korean version (AUDIT-K) [15,16]. The AUDIT-K has demonstrated good reliability and validity in Korean populations [16] and is also used in national addiction surveillance, ensuring comparability with current epidemiological data on alcohol use in Korea [12]. AUDIT-K was administered only to current drinkers, in accordance with the survey protocol of the Korea National Health and Nutrition Examination Survey (KNHANES).

Current drinkers

Current drinkers were those who responded "Yes" to the question, "Do you currently drink alcohol?", and the AUDIT-K was administered only to this group.

Past drinkers

Past drinkers were those who answered "No" to the same question but reported a history of alcohol drinking.

Non-drinkers

Non-drinkers were participants who reported no history of alcohol use.

Information regarding the duration of abstinence or reasons for quitting (e.g., medical advice, health problems, or personal decision) was not available in the dataset.

Hazardous drinkers

Defined as those with an Alcohol Use Disorders Identification Test (AUDIT) score ≥8.

Chronic diseases

Chronic diseases were defined according to self-reported physician diagnoses, based on the standardized questionnaire of the Korea National Health and Nutrition Examination Survey. Participants were asked, "Have you ever been diagnosed with [disease] by a doctor?" and "When was your condition diagnosed?" Responses were used to classify whether a participant had ever been diagnosed with each condition. Accordingly, these variables represent lifetime prevalence rather than incidence or current disease status. Broad categories such as "liver disease" and "kidney disease" were used as defined in the KNHANES questionnaire without additional clinical criteria.

Statistical analysis

Analyses were conducted using SPSS version 28.0 (IBM Corp.). Descriptive and correlation analyses were performed, followed by logistic regression to examine associations between alcohol use and chronic disease diagnoses. Binary logistic regression was employed to evaluate the explanatory power of sociodemographic and health-related variables. Statistical significance was set at P <0.05, with Fisher's exact tests applied when appropriate. Analyses were adjusted for age, body mass index (BMI), education level, economic activity, physical activity, regular diet habits, smoking.

RESULTS

Table 1 presents the general vision disorders included in the study. The mean age of participants was 66.2±8.76 years, and the mean BMI was 24.1±2.77 kg/m^2. Most participants (75.1%) had an education level up to high school, and 65.8% reported having two or more chronic diseases. Regarding lifestyle behaviors, 40.1% engaged in excessive physical activity, while 37.6% showed insufficient levels. Nearly half of the participants (44.3%) reported poor eating habits, and 48.1% were classified as hazardous drinkers (AUDIT≥8). In addition, 21.9% were current smokers, and 52.3% were past smokers.

Fig. 1 presents the prevalence of chronic diseases among participants with vision disorders. The most common chronic condition was hypertension (22.8%), followed by liver disease

Table 1. General characteristics of men with vision disorders

Variable	Value
Age (yr)	66.2±8.76
BMI (kg/m^2)	24.1±2.77
Education level	
Up to high school level	178 (75.1)
College or higher	59 (24.9)
Multimorbidity (≥2)	
≤1 chronic disease	81 (34.2)
≥2 chronic diseases	156 (65.8)
Physical activity	
Insufficient physical activity	89 (37.6)
Sufficient physical activity	53 (22.4)
Excessive physical activity	95 (40.1)
Healthy eating habits	
Good	30 (12.7)
Moderate	102 (43.0)
Poor	105 (44.3)
Drinking	
Current drinking	138 (58.2)
Past drinking	80 (33.8)
Non-drinker	19 (8.0)
Smoking	
Current smoking	52 (21.9)
Past smoking	124 (52.3)
Non-smoking	61 (25.7)
Drinking	
Current drinking	138 (58.2)
Past drinking	80 (33.8)
Non-drinker	19 (8.0)
AUDIT	
Normal drinking (AUDIT 0–7)	123 (51.9)
Hazardous drinking (AUDIT 8–15)	52 (21.9)
Harmful drinking (AUDIT≥16)	62 (26.2)

Values are presented as mean±standard deviation or number (%).
AUDIT, Alcohol Use Disorders Identification Test; BMI, body mass index.

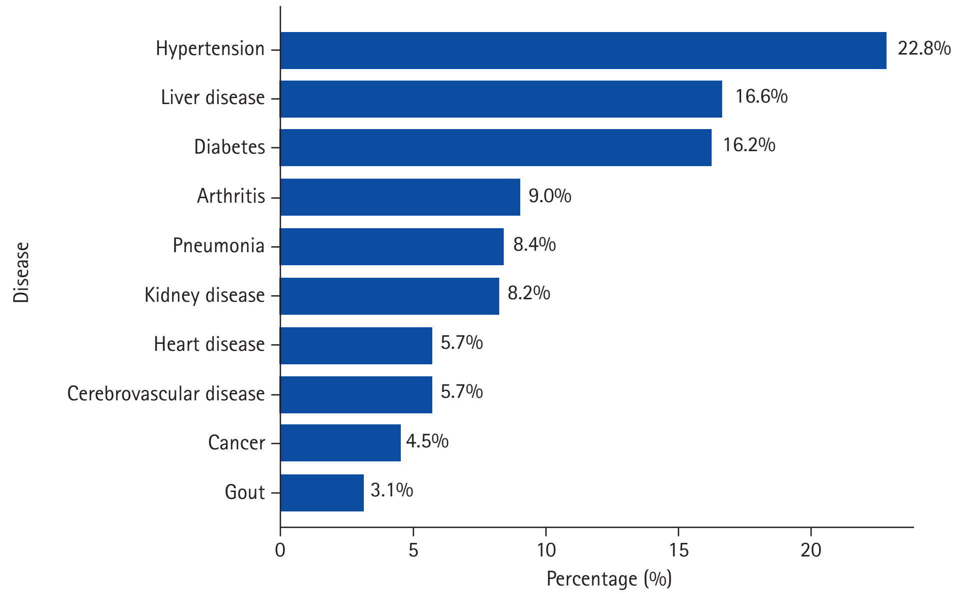

Fig. 1. Prevalence of chronic diseases.

(16.6%) and diabetes (16.2%). Arthritis (9.0%), pneumonia (8.4%), and kidney disease (8.2%) were also relatively prevalent. In contrast, heart disease (5.7%), cerebrovascular disease (5.7%), cancer (4.5%), and gout (3.1%) showed lower prevalence rates. Overall, hypertension, liver disease, and diabetes were the most frequently reported chronic conditions in this population.

Fig. 2 presents the overall burden of multimorbidity. Only 11.8% of participants reported no chronic conditions, while 22.4% had one and 28.3% had two. Multimorbidity (≥3 conditions) was observed in 37.6% of participants, with 7.2% reporting five or more conditions. These findings indicate that a substantial proportion of vision disorders men face complex challenges related to chronic disease management.

Logistic regression analyses were conducted to examine the association between current alcohol drinking and the prevalence of chronic diseases, using past drinkers/non-drinkers as the reference group. The odds ratios (ORs) and 95% confidence intervals (CIs) are presented in Table 2.

Compared with past drinkers/non-drinkers, current drinkers showed a significantly lower odds of heart disease (OR=0.16, 95% CI=0.04–0.59, *P*=0.006) and pneumonia (OR=0.28, 95% CI=0.11–0.75, *P*=0.011) showed significantly lower risks among current drinkers compared to past drinkers or non-drinkers. In contrast, arthritis (OR=3.08, 95% CI=1.06–8.96, *P*=0.039) showed a significantly higher risk among current drinkers.

Although cerebrovascular disease (OR=2.91, 95% CI=0.91–

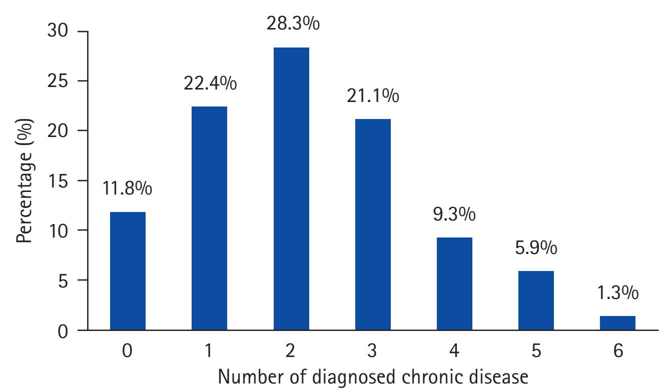

Fig. 2. Distribution of the number of chronic diseases.

9.34, *P*=0.073) was not statistically significant, it tended to show an increased risk in current drinkers. Other diseases, including cancer, diabetes, liver disease, hypertension, kidney disease, and gout, did not show significant differences.

Among drinkers, the prevalence of chronic diseases was further compared between hazardous drinkers (AUDIT≥8) and non-hazardous drinkers (AUDIT<8). As shown in Table 3, hazardous drinkers had significantly higher prevalence of cancer (15.1% vs. 5.4%, *P*=0.023) and liver disease (43.4% vs. 28.6%, *P*=0.024).

Finally, Table 4 shows the association between the AUDIT risk groups and chronic diseases using binary logistic regression analysis adjusted for age, BMI, economic activity, physical activ-

Table 2. Alcohol drinking and chronic disease risk[a]

Disease	Current drinker vs. past drinker/non-drinker		
	OR	95% CI	*P*-value
Cancer	0.67	0.21–2.20	0.511
Heart disease	0.16	0.04–0.59	0.006*
Pneumonia	0.28	0.11–0.75	0.011*
Cerebrovascular disease	2.91	0.91–9.34	0.073
Diabetes	0.89	0.39–2.02	0.778
Liver disease	0.88	0.39–2.00	0.759
Hypertension	1.10	0.49–2.47	0.815
Kidney disease	0.49	0.18–1.34	0.166
Gout	0.81	0.18–3.56	0.779
Arthritis	3.08	1.06–8.96	0.039*

OR, odds ratio; CI, confidence interval.
[a]Reference group: past drinkers/non-drinkers; B and standard error values were omitted to improve the readability and clarity of the table.; Adjusted by age, body mass index, education level, economic activity, physical activity, regular diet habits, and smoking.
*$P<0.05$ was considered statistically significant.

Table 3. Prevalence of chronic diseases by AUDIT score 8 among men with vision disorders

Disease	AUDIT≥8	AUDIT<8	χ^2	*P*-value
Cancer	6 (5.4)	16 (15.1)	5.69	0.023*
Heart disease	12 (10.7)	14 (13.2)	0.32	0.677
Pneumonia	18 (16.1)	20 (18.9)	0.29	0.598
Cerebrovascular disease	12 (10.7)	17 (16.0)	1.33	0.319
Diabetes mellitus	37 (33.0)	40 (37.7)	0.52	0.482
Liver disease	32 (28.6)	46 (43.4)	5.20	0.024*
Hypertension	58 (51.8)	55 (51.9)	0.00	>0.99
Kidney disease	18 (16.1)	21 (19.8)	0.51	0.485
Gout	9 (8.0)	5 (5.7)	0.48	0.596
Osteoarthritis	25 (22.3)	18 (17.0)	0.98	0.395

Values are presented as number (%). Multiple responses were allowed for chronic disease items.
AUDIT, Alcohol Use Disorders Identification Test.
P-values were obtained using chi-square test unless otherwise indicated (*$P<0.05$).

ity, regular diet habits, and smoking status.

Among the diseases examined, only diabetes showed a statistically significant association with the high-risk drinking group (AUDIT≥16). Specifically, individuals with an AUDIT score ≥16 had a significantly higher odds of having diabetes (OR=9.00, 95% CI=1.68–48.14, $P<0.05$) compared to those with lower scores.

No significant associations were observed for other chronic diseases, including cancer, heart disease, liver disease, hypertension, kidney disease, gout, or osteoarthritis ($P>0.05$). Although cerebrovascular disease showed a relatively high OR (OR=12.25) in the high-risk drinking group, this result was not statistically significant due to the wide CI.

Table 4. ORs of chronic diseases by AUDIT risk levels

Disease	AUDIT≥8		AUDIT≥16	
	OR	95% CI	OR	95% CI
Cancer	1.26	0.40–4.00	1.68	0.25–11.24
Heart disease	2.07	0.66–6.57	6.86	0.68–69.00
Pneumonia	1.58	0.65–3.86	1.49	0.25–8.90
Cerebrovascular disease	0.43	0.16–1.21	12.25	0.66–228.57
Diabetes	0.62	0.27–1.33	9.00	1.68–48.14*
Liver disease	0.61	0.29–1.28	2.32	0.58–9.38
Hypertension	1.05	0.50–2.20	0.81	0.20–3.39
Kidney disease	2.40	0.89–6.50	1.10	0.21–5.70
Gout	1.38	0.35–5.37	0.16	0.02–1.67
Osteoarthritis	0.92	0.38–2.23	1.00	0.23–4.50

Binary logistic regression models were adjusted for age, body mass index, and economic activity status, physical activity, regular diet habits, smoking.
AUDIT, Alcohol Use Disorders Identification Test; CI, confidence interval; OR, odds ratio.
Statistical significance was set at *$P<0.05$.

These findings suggest that heavy alcohol drinking, as indicated by higher AUDIT scores, may be strongly associated with an increased risk of diabetes, while its relationship with other chronic diseases remains inconclusive.

DISCUSSION

This study was conducted to examine the Associations of Alcohol Drinking with Chronic Diseases among Korean Men with Severe Vision Disorders. In this study, current drinkers showed a lower prevalence of heart disease and pneumonia compared to past or non-drinkers, whereas the prevalence of arthritis was higher. These findings are more likely to reflect reverse causality, resulting from changes in drinking habits after disease diagnosis, rather than a simple causal relationship. In particular, the lower ORs observed for heart disease and pneumonia may be due to individuals who quit or reduced drinking after being diagnosed with chronic diseases being categorized into the past/non-drinker group.

On the other hand, the approximately three-fold higher prevalence of arthritis among current drinkers suggests that alcohol drinking may act as an aggravating factor for inflammatory responses or certain conditions such as gouty arthritis [17].

No significant differences were found for other diseases such as liver disease, diabetes, or hypertension, which may be due to a combination of factors including limited sample size, diversity of drinking patterns, and behavioral changes following disease diagnosis. These findings suggest that alcohol drinking should be understood not as a direct cause of chronic diseases, but rather within the context of interactions between disease diagnosis and subsequent health behavior changes.

According to another study, past drinking among men with disabilities was associated with chronic diseases such as cerebrovascular and heart diseases [18], and similar results have been reported among elderly individuals with hypertension, where high-risk drinking was identified as a major factor contributing to health deterioration [12].

Past drinking experiences remain strong predictors of chronic diseases such as heart disease and chronic kidney disease, indicating accumulated health risks [19]. The apparent preventive effect of current drinking in this study may be related to behavioral changes following disease diagnosis [20], as individuals may have reduced or ceased alcohol drinking after being diagnosed with chronic conditions [21,22]. These findings highlight the long-term and cumulative impact of alcohol on chronic disease risk. The interpretation of the associations between past drinking and chronic diseases should consider the operational definition of past drinkers. In this study, past drinkers were defined as respondents who had consumed alcohol in the past but were not drinking at the time of the survey, without detailed information on the duration or cause of abstinence. Consequently, differences in the length or reason for quitting may have influenced the observed associations with specific chronic diseases such as heart or kidney disease.

This aligns with global evidence from the WHO and CDC, both of which identify alcohol as a major cause of non-communicable diseases [2-4]. Furthermore, these patterns suggest the possibility of reverse causality—where individuals reduce or stop drinking after being diagnosed with chronic diseases, either following medical advice or as part of self-directed health management. Similar trends have been observed in previous studies showing decreased alcohol drinking after diagnoses of cardiovascular disease, diabetes, or kidney disease. Data from the Korea Health Panel also confirmed this reverse causality, showing that adults reduced alcohol intake after being diagnosed with chronic diseases [13].

Consistent with national and international studies individuals with vision disorders demonstrate higher rates of hazardous drinking but lower participation in smoking cessation or alcohol reduction programs. Barriers such as limited access to health information, restricted opportunities for physical activity, and inadequate community resources contribute to structural health inequities. Evidence from the United States also supports these findings, showing that older adults with vision disorders have higher prevalence of chronic conditions and greater functional limitations compared with non-impaired peers [23]. Large-scale comparative studies have likewise reported that individuals with vision disorders have significantly higher prevalence of hypertension, heart disease, stroke, arthritis, and asthma [23]. Population-based analyses in Korea further demonstrated that people with vision disorders experience substantially higher rates of stroke, cardiovascular disease, hypertension, and diabetes than the general population [24]. These results emphasize that alcohol-related risks identified in this study must be understood within the broader context of chronic disease disparities associated with vision disorders. Additional analyses of older adults with diabetes have also shown that those who with vision disorders are at heightened risk of malnutrition and chronic disease complications [14].

This study underscores the importance of addressing alcohol use not only as an individual behavior but also within broader social and policy contexts. Expanding access to health promotion resources, enhancing preventive screening, and providing disability-inclusive healthcare environments are essential. Evidence suggests that disability support services can significantly improve healthcare utilization among people with disabilities, including those who with vision disorders [4]. Systematic reviews also indicate that tailored chronic disease interventions—such as accessible health education materials and integrated care programs—can reduce disparities and improve outcomes [25]. For visually impaired individuals, future interventions should include targeted alcohol prevention and education initiatives. These may involve Braille and audio materials, accessible mobile health applications, peer-support groups within disability communities, and collaboration with local welfare centers to ensure sustained participation. Such strategies would not only improve knowledge and awareness but also provide practical support for adopting and maintaining healthier behaviors. This approach is consistent with primary care–based interventions, where alcohol reduction programs embedded within broader lifestyle modifications have been shown to improve health outcomes [26].

Limitations of this study include reliance on self-reported chronic disease diagnoses, the cross-sectional design that precludes causal inference, the absence of a non-disabled control group and the restriction of the sample to men only. The focus on men reflected both their higher prevalence of chronic diseases in older age groups and the feasibility of recruitment through vocational training and welfare centers, but it limits the generalizability of findings to women with vision disorders. Furthermore, national surveillance reports continue to document persistent health inequities among people with disabilities in Korea, reinforcing the need for policy-level interventions [11-13]. Despite these limitations, this study contributes novel empirical evidence on the intersection of alcohol use and chronic diseases in a vulnerable population. Unlike earlier research that primarily addressed general health behaviors or healthcare access among people with disabilities, this study is the first to specifically analyze alcohol use patterns in relation to chronic disease diagnoses among older men with severe vision disorders, providing unique evidence to guide tailored public health interventions.

Summary

This study analyzed associations between alcohol drinking behaviors and chronic disease diagnoses among severe vision disorders men aged 50 years or older. Past drinkers/non-drinkers showed a significantly lower odds of heart disease and pneumonia. In contrast, arthritis showed a significantly higher risk among current drinkers. Hazardous drinkers (AUDIT-K score≥8) showed a higher prevalence of cancer and liver disease compared with non-hazardous drinkers. Hazardous drinking was associated with 9.00-fold increased risk of diabetes. These findings highlight the need for tailored alcohol reduction and health promotion interventions for individuals with vision disorders, emphasizing integrated approaches that extend beyond individual behavior to social and policy contexts.

ORCID

Sunmee YUN-WELCH, https://orcid.org/0009-0008-6153-5056
Sunhee KIM, https://orcid.org/0000-0001-9559-5796
Jeehoon LEE, https://orcid.org/0009-0007-7181-0288
Mieun YUN, https://orcid.org/0000-0001-5630-0035
Geumseon LEE, https://orcid.org/0000-0001-8335-2455

AUTHOR CONTRIBUTIONS

Dr. Geumseon LEE had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: SYW, SK, JL, and GL. Data curation: SK, MY, and GL. Formal analysis: SK and MY. Software, Supervision: JL, MY, and GL. Writing–original draft: SYW and GL. Writing–review & editing: all authors.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

FUNDING

None.

DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

REFERENCES

1. Ministry of Health and Welfare, Korea Institute for Health and Social Affairs. Survey on persons with disabilities 2020. Ministry of Health and Welfare; 2020 Dec. Report No. 11-1352000-000568-12.
2. World Health Organization (WHO). Global status report on alcohol and health 2018. WHO; 2018.
3. World Health Organization (WHO). Disability and health: fact sheet [Internet]. WHO; 2023 Mar 7 [cited 2025 Sep 29]. Available from: https://www.who.int/news-room/fact-sheets/detail/disability-and-health
4. Centers for Disease Control and Prevention (CDC). Disability and health data system (DHDS). CDC; 2020.
5. Jeon B, Koo H, Choi HK, Han E. The impact of visual impairment on healthcare use among four medical institution types: a nationwide retrospective cohort study in Korea. Yonsei Med J 2023;64(7):455-62.
6. Cho MJ, Seong SJ, Park JE, Chung IW, Lee YM, Bae A, et al. Prevalence and correlates of DSM-IV mental disorders in South Korean adults: the Korean Epidemiologic Catchment Area Study 2011. Psychiatry Investig 2015;12(2):164-70.
7. Na KI, Lee WJ, Kim YK. Trends in the prevalence of blindness and correlation with health status in Korean adults: a 10-year nationwide population-based study. J Korean Med Sci 2023;38(28):e213.
8. Crews JE, Chou CF, Zhang X, Zack MM, Saaddine JB. Health-related quality of life among people aged ≥65 years with self-re-

ported visual impairment: findings from the 2006-2010 behavioral risk factor surveillance system. Ophthalmic Epidemiol 2014;21(5):287-96.
9. Oh SS, Lee S, Jang SI, Park EC. Chronic alcoholism and all-cause mortality among disabled individuals: findings from the Korea National Health Insurance Service-National Sample Cohort. Alcohol. 2020;89:57-62.
10. Lee HK. Epidemiology of alcohol use disorders and alcohol policy. J Korean Neuropsychiatr Assoc 2019;58(3):152-8.
11. National Rehabilitation Center. 2018 Survey on health behaviors of people with disabilities. National Rehabilitation Center; 2018.
12. National Center for Mental Health. Indicators of addiction in Korea 2024. Ministry of Health and Welfare; 2024.
13. Park E. Changes in health behaviors as examined by the Korean health panel (2010-2018): smoking, drinking, and physical activity in adults and the elderly [Internet]. Korea Institute for Health and Social Affairs; 2021 Aug 2 [cited 2025 Sep 29]. Available from: https://repository.kihasa.re.kr/handle/201002/38120
14. Yang E, Lee KH. Association between visual impairment and nutritional risk among older adults with diabetes: a population-based cross-sectional study. J Korean Acad Nurs 2023; 53(2):167-76.
15. Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption: II. Addiction 1993;88(6):791-804.
16. Lee BO, Lee CH, Lee PG, Choi MJ, Namkoong K. Development of Korean version of Alcohol Use Disorders Identification Test (AUDIT-K): its reliability and validity. J Korean Acad Addict Psychiatry 2000;4(2):83-92.
17. Feng Y, Sun H, Zhu R, Tao J, Su R, Sun Y, et al. Effects of alcohol on the symptoms of gouty arthritis and taxonomic structure of gut microbiota in C57BL/6 mice. Front Microbiol 2023;14:1257701.
18. Kim JY, Kang MW, Seo WY, Lee JW. Chronic diseases, health behaviors, and mortality in persons with disabilities: an analysis of the National Health Insurance Service-Health Screening (NHIS-HEALS) database. Health Soc Welf Rev 2020;40(2):121-50.
19. Tanaka A, Yamaguchi M, Ishimoto T, Katsuno T, Nobata H, Iwagaitsu S, et al. Association of alcohol consumption with the incidence of proteinuria and chronic kidney disease: a retrospective cohort study in Japan. Nutr J 2022;21(1):31.
20. Jeon YJ, Pyo J, Park YK, Ock M. Health behaviors in major chronic diseases patients: trends and regional variations analysis, 2008-2017, Korea. BMC Public Health 2020;20(1):1813.
21. Kang DO, Lee DI, Roh SY, Na JO, Choi CU, Kim JW, et al. Reduced alcohol consumption and major adverse cardiovascular events among individuals with previously high alcohol consumption. JAMA Netw Open 2024;7(3):e244013.
22. Hu Y, Chen Q, Zhang B. Effects of chronic disease diagnoses on alcohol consumption among elderly individuals: longitudinal evidence from China. BMJ Open 2022;12(10):e062920.
23. Crews JE, Campbell VA. Health conditions, activity limitations, and participation restrictions among older people with visual impairments. J Vis Impair Blind 2001;95(8):453-67.
24. Kim KN, Park SJ, Kim W, Joo J, Kim H, Kim KH, et al. Modification of the association between visual impairment and mortality by physical activity: a cohort study among the Korean National Health Examinees. Int J Environ Res Public Health 2019;16(22):4386.
25. Kim HJ, Chang SJ, Yang E, Jeong HN. Chronic disease interventions for people with visual impairment: a systematic review. Appl Nurs Res 2021;60:151446.
26. Ashenden R, Silagy C, Weller D. A systematic review of the effectiveness of promoting lifestyle change in general practice. Fam Pract 1997;14(2):160-76.

Korean Journal of Health Promotion
KJHP

Instructions for Authors

Revised in January, 2024 (6th)
Revised in January, 2016 (5th)
Revised in June, 2011 (4th)
Revised in June, 2009 (3rd)
Revised in June, 2007 (2nd)
Revised in March, 2003 (1st)
Enacted in March, 2001

The Korean Journal of Health Promotion (KJHP) is an open access, multidisciplinary journal dedicated to publishing high-quality research in various areas of the medical, nursing, nutritional, physical educational, epidemiological, and public health sciences associated with health promotion and disease prevention.

The manuscript should be prepared according to the “ICMJE Recommendations for the Conduct, Reporting, and Publication of Scholarly Work in Medical Journals” (2023) (https://www.icmje.org/recommendations/). Matters unspecified in this document will follow the general principles of writing and editing of biomedical publication.

1. MANUSCRIPT SUBMISSION

All manuscripts must be submitted online via the online manuscript submission and review system for *KJHP* (https://submit.e-kjhp.org/)

Editor-in-Chief
Prof. Seung-Kwon MYUNG, MD, PhD
Department of Family Medicine, National Cancer Center
Department of Public Health & AI, National Cancer Center
Graduate School of Cancer Science and Policy

Editorial Office
Department of Family Medicine, Asan Medical Center, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea

Tel: +82-2-3010-3820
Tel: +82-2-3010-3815
E-mail: kshpdp@amc.seoul.kr
For manuscript submission, please visit https://submit.e-kjhp.org/

2. CATEGORIES OF ARTICLES

KJHP publishes original articles, review articles (narrative reviews and systematic reviews without meta-analyses), letters to the editor, letters in reply, editorials, and viewpoints.

*Summary of Article Types

Article Type	Description	Requirements
Original Article	Cross-sectional study Case-control study Cohort study Clinical trial Meta-analysis Qualitative research Survey research Other observational or original research	• ≤3,500 words • ≤10 tables and/or figures • Structured abstract, ≤300 words • Key Points: Question, Findings, and Meaning, ≤100 words • ≤50 references • Title Page including Key Points • Manuscript text: Title, Abstract, Keywords, Introduction, Methods, Results, Discussion, Acknowledgments, Author Contributions, References, Figure Legends, and Tables • Figures uploaded separately • Cover letter
Review Article	Narrative review (general review) Systematic review without meta-analysis	• ≤3,500 words • ≤10 tables and/or figures • Unstructured abstract for narrative review and structured abstract for systematic review, ≤300 word • Key Points: Question, Findings, and Meaning, ≤100 words • ≤50 references • Subtitle should be ‘A Narrative Review or A Systematic Review’ • Title Page including Key Points • Manuscript text: Title, Abstract, Keywords, Introduction, Methods, Results, Discussion, Acknowledgments, Author Contributions, References, Figure Legends, and Tables • Figures uploaded separately • Cover letter

Letter to the Editor	Letters discussing a recent article in this journal should be submitted within 4 weeks of the article's publication in print.	• ≤1,000 words • ≤5 references • ≤3 authors • No abstract required
Letter in Reply	Replies by authors of original articles to letters from readers.	• ≤1,000 words • ≤5 references • ≤3 authors • No abstract required
Editorial	An opinion or a view of a member of the editorial board or any senior or reputed faculty written in a journal	• ≤1,000 words • 1 author • No abstract required
Viewpoint	A short opinion which focuses on some of the key topics, issues, or developments in health promotion and disease prevention	• ≤1,500 words • ≤10 references • ≤3 authors • Unstructured abstract, ≤150 words

3. MANUSCRIPT PREPARATION AND SUBMISSION REQUIREMENTS

1) Original Article and Review Article

Manuscript Style

Manuscripts should be prepared in accordance with the ICMJE Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals (https://icmje.org/recommendations) and written in proper and clear English.

Manuscript Components

The authors should prepare at least 3 files such as a cover letter, title page (with author details), manuscript text (no author identifiers), and as appropriate, figures. Start each of these sections on a new page, numbered consecutively. Tables should be included in the manuscript text, and figures should be uploaded as separate files (individual or combined figure files) and not included in the manuscript text. Also, a copyright transfer form should be signed by a corresponding author on behalf of all authors and submitted (a link for downloading the form should be inserted here).

Manuscript File Formats

For submission and review, please submit the manuscript as a Word document (e.g., Microsoft Office Word). Do not submit your manuscript in PDF format. For submission of drawings, photos, graphs, or combined figures, PPT and PDF formats are acceptable.

Use 12-point font size, double-space text, and leave both margins justified.

Cover Letter (≤200 words)

Prepare a cover letter. This is a great opportunity to highlight to the journal editor what makes your research new and important. The cover letter should explain why your work is perfect for the *KJHP* and why it will be of interest to our readers. The cover letter should have a maximum of 200 words and include complete contact information for the corresponding author (affiliation, postal/mail address, email address, and telephone number) and whether the authors have published, posted, or submitted any related papers from the same study.

Title Page (≤300 words)

The title page should include an article title; running head; type of study design; the full names, academic degrees, and affiliations of all authors (if an author's affiliation has changed since the work was done, the new affiliation also should be listed); name and complete contact information for corresponding author; word count of the abstract and manuscript text (not including title, abstract, acknowledgment, references, tables, and figure legends); total number of tables; total number of figures; number of references; funding sources; declaration of conflict of interests; and key points.

Provide ORCID IDs for all authors. Titles should be concise, specific, and informative. Limit the length of titles to 30 words. A running head or running title is a short version of the article title, which should consist of no more than 10 words.

The key points is a short structured summary of the findings of your manuscript (required only for research and review manuscripts), following 3 key points: Question, Findings, and Meaning. Limit to 100 words or less.

<*Example*>

Key Points

Question: Is intermittent high-dose vitamin D supplementation effective in the prevention of falls and fractures?

Findings: In this meta-analysis of 15 randomized controlled trials, intermittent high-dose vitamin D supplementation showed no beneficial effect in the prevention of falls and fractures and even showed a harmful effect in the high-quality trials.

Meaning: Our findings support that intermittent high-dose vitamin D supplementation for the prevention of falls and fractures should be discouraged.

Manuscript Text
A manuscript text should be prepared in the following sequence: title, abstract, keywords, introduction, methods, results, discussion, acknowledgments, author contributions, references, figure legends, and tables. The full text containing introduction, methods, results, and discussion should not exceed 3500 words.

Title (≤30 words)
An article title should be inserted at the top of the first page of the manuscript text file.

Abstract (≤300 words) and Keywords
An abstract should briefly summarize the content of the manuscript in a structured format for a systematic review and a unstructured format for a narrative review and should not exceed 300 words. The structured abstract should be structured as follows: Background, Methods, Results, and Conclusions. Three to six keywords should be listed after the abstract.

Introduction (≤500 words)
Desribe a brief background and purpose of the study and elaborate on its significance. Summarize the rationale and include only strictly pertinent references.

Methods (≤1,000 words)
Identify the methods. Describe study participants, controls, or laboratory animals clearly and identify procedures in sufficient details to allow other researchers to reproduce the results. Identify the apparatus or reagents used by giving the product's name, followed by the name of the product company in parentheses. Give references to established methods, including statistical methods. Provide references and brief descriptions for methods that have been published but are not well known or substantially modified, and give reasons for using them and evaluate their limitations.

Describe statistical methods with enough details to verify the reported results. Whenever possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Avoid relying solely on statistical hypothesis testing, such as the use of *P*-values, which fails to convey important quantitative information. When the results of the data in the text are given, provide details specifically in terms of average, proportion, or correlation coefficient to describe the difference between study groups or the relevant size and direction of variables. Specify statistical software used for statistical analysis.

Results (≤1,000 words)
Present the findings and results in logical sequence in the text, tables, and figures. Do not repeat in the text all data in the tables or figures, but describe important points and trends.

Discussion (≤1,000 words)
Emphasize the new and important aspects of the study and the conclusions that follow from them. Do not repeat in detail data or other materials given in the Introduction or the Results section. Include the implications of the findings and their limitations, including implications for future research. Link the conclusions with the purpose of the study by discussing and comparing the relevant results of other research data. Avoid unqualified statements and conclusions not completely supported by the data. Propose new hypotheses when warranted and recommendations, when appropriate, may be included.

Acknowledgments
If necessary, persons who have contributed to the article but whose contributions do not meet authorship standards may be appreciated through acknowledgment section. Clearly state their contributing role for acknowledgement. For example, data collection, financial support, statistical analysis, analysis of experiment, and so forth. Authors should notify that their names will be in the Acknowledgement and are responsible for obtaining permission from persons acknowledged.

Author Contributions
What authors have done for the study should be described in this section. To qualify for authorship, all contributors must meet at least one of the seven core contributions by CRediT (conceptualization, methodology, software, validation, formal analysis, investigation, data curation), as well as at least one of the writing contributions (original draft preparation, review, and editing).

The submitting author is responsible for completing this information at submission, and it is expected that all authors will have reviewed, discussed, and agreed to their individual contributions ahead of this time.

<Example>
Dr. MYUNG had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy

of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: SKM.
Data curation: SWO and YJC.
Formal analysis: YJC.
Methodology: SKM, SWO, and YJC.
Software: SKM and YJC.
Writing - original draft: YJC.
Writing - review & editing: SKM, SWO, and YJC.

References

Authors are responsible for the accuracy and completeness of their references and for correct text citation. In the text, references should be cited with Arabic numerals in brackets, numbered in the order cited. In the references section, the references should be numbered and listed in order of appearance in the text. If there is more than one reference cited coincidentally, then a comma separates the numbers and only the last number is closed with a right bracket. If a consecutive number of references is cited together, then a hyphen '-' should be used between the first and the last number.

List all authors and/or editors up to 6; if more than 6, list the first 6 followed by "et al." Journal references should include the issue number in parentheses after the volume number. Reference styles are as follows:

Journal articles

Name(s) of author(s). Title of article. Abbreviated journal name. Year of publication;Volume number (Issue number):Page numbers.

<Example> Myung SK, Oh SW, Choi YJ. How to use the KJHP's online manuscript submission system. Korean J Helath Promot 2024;24(1):123-7.

Books

Name(s) of author(s). Title of publication: subtitle. Edition. Publisher; Year of publication. p. Page numbers.
Name(s) of the chaptor's author(s). Title of chapter. In: Name(s) of the editor(s). Title of publication. Edition. Publisher; Year of publication. p. Page numbers.

Conference proceedings

Name(s) of author(s). Title of conference proceedings. Title of conference; Date of conference; Place of conference. Publisher; Year of publication.

Dissertations

Name of author. Title of thesis [dissertation]. Name of university; Year when degree was given. Language of dissertation.

Journal articles in electronic media

Name(s) of author(s). Title of article. Abbreviated title of journal [Internet]. Year of publication;Volume number (Issue number):Page numbers. Name of source URL:

Website or online sources

Name(s) of author(s). Title of web page [Internet]. Name of publisher; Year of publication [Date of citation]. Available from: available URL

Figure Titles and Legends (Captions)

After references, include a title for each figure. The figure title should be a brief descriptive phrase, preferably no longer than 10 to 15 words. A figure legend (caption) can be used for a brief explanation of the figure or markers if needed and expansion of abbreviations.

Tables

All tables should be inserted after figure legends in the manuscript text. Restrict tables and figures to those needed to explain and support the argument of the article and to report all outcomes identified in the Methods section. Number each table and figure and provide a descriptive title for each. Every table and figure should have an in-text citation. Verify that data are consistently reported across text, tables, figures, and supplementary material. The number of tables and /or figures should not exceed 10.

Within a table, if an abbreviation is used or a description may be necessary, then list them under annotation below. Use the alphabet in the order of a, b, c by superscript on the right side of the part that needs explanation and the annotation should be recorded according to the symbols listed below the table. For each annotation marked, the first letter of the first word should be capitalized. The *P* of the *P*-value should also be capitalized. The title of the table should be on the top placed at the right end of the table. The title of the figure should also be on the top placed at the right end of the figure. The numbering of the table or figure should be in the order of entry in the main text, and Arabic numeral should be used after a space of the word 'Table (Figure)' followed by a period. The first letter of the first word should be capitalized. In making a table, the average and standard deviation, the number of participants and other figures should be given and on the annotated part of the table, the applied statistical method should be noted. For ratio, the number of responders and the ratio, and for correlation coefficient, the value of correlation coefficient should be given, respectively.

Figures

Number all figures (graphs, charts, photographs, and illustrations) in the order of their citation in the text. When illustrating a figure, use a bar or a line graph for average or proportion, and list measures using standard deviation or standard error and must show their *P*-values. Identify the applied statistical methods at the footnote of each figure. Primary outcome data should not be presented in figures alone. Exact values with measure of variability should be reported in the text or table as well as in the abstract. All symbols, indicators (including error bars), line styles, colors, and abbreviations should be defined in a legend. Each axis on a statistical graph must have a label and units of measure should be labeled. Error bars should be included in both directions, unless only 1-sided variability was calculated.

Acceptable file formats are .jpg, .tif, .pdf, .ppt, .psd, and .eps. Required minimum resoultion for publication is 300 ppi.

Abbreviations

Overindulgence with the use of abbreviations is forbidden, and the use of abbreviations must be minimized. Only standardized abbreviations may be used and abbreviations should not be used in titles or abstracts. With the exception of measurement units, abbreviation should be specified when first introduced in the text and then may be used independently.

Units of Measurement

Laboratory values are expressed using conventional units of measure, with relevant Systeme International (SI) conversion factors expressed secondarily (in parentheses) only at first mention. Figures and tables should use conventional units, with conversion factors given in legends or footnotes. The metric system is preferred for the expression of length, area, mass, and volume.

Names of Drugs, Devices, and Other Products

Generic names should be used. When proprietary brands are used in research, include the brand name and the name of the manufacturer in parentheses after the first mention of the generic name in the Methods section.

Generic Names, Numbers, and Measurement Units

Personal, geographical and generic names must be written in original language, if possible, and numbers must be written in Arabic numerals. The measurement units such as length, height, mass and volume should be indicated in the metric system (meter, kilogram, liter etc). Temperature must be indicated in centigrade and blood pressure in mmHg. Units for blood and clinical laboratory test measurements should be expressed in the ordinary scale or by International Units (SI). A space is required between a measured value and its unit.

Supplementary Materials

Supplementary materials for online-only publication can be submitted, when there is insufficient space to include the materials in the manuscript text or figures. Because supplementary materials are not edited or formatted after publication, authors are responsible for the accuracy and presentation of these materials.

Reporting Sex/Gender

The term sex (male, female) should be used when reporting biological factors and gender (man, woman) should be used when reporting gender identity or psychosocial/cultural factors. The methods used to obtain information on sex, gender, or both (e.g., selfreported, investigator observed or classified, or laboratory test) should be explained in the Methods section. If only one sex is reported, or included in the study, the reason the other sex is not reported or included should be explained in the methods section, except for studies of diseases/disorders that only affect males (e.g., prostate disease) or females (e.g., ovarian disease). The sex distribution of study participants or samples should be reported in the results section, including for studies of humans, tissues, cells, or animals. Study results should disaggregate and report all outcome data by sex.

2) Letters to the Editor, Letters in Reply, Editorials, and Viewpoints

For preparation of Letters to the Editor, Letters in Reply, Editorials, and Viewpoints, refer to 'Summary of Article Types' in the categories of articles secction.

4. REPORTING GUIDELINES FOR SPECIFIC STUDY DESIGNS

Authors should be aware of the information that must be included in the contents of the research according to the study design and must reflect them in their articles. Authors should refer to STROBE (http://www.strobe-statement.org) for observational studies, CONSORT (http://www.consort-statement.org) for randomized controlled trials, STARD (http://www.stard-statement.org) for studies of diagnostic accuracy, and PRISMA (https://www.equator-network.org/reporting-guidelines/prisma/) and MOOSE (https://www.equator-network.org/reporting-guidelines/meta-analysis-of-observational-studies-in-epidemiology-a-proposal-for-reporting-meta-analysis-of-observational-studies-in-epidemiology-moose-group/) for systematic reviews and meta-analyses.

5. MANUSCRIPT REVIEW AND PUBLICATION

Upon submission of a manuscript, the Editorial Committee will review the article whether its contents meet the objectives of the Journal, and the article can be rejected at this initial review process. The Editorial Committee will entrust two or more experts with review of articles and will decide their acceptance for publication with the help of experts' recommendations. Based on comments from reviewers and editors, authors may be asked to revise their manuscripts. Authors are required to submit a revised manuscript and a letter of explanation regarding how they have dealt with all comments and questions raised by reviewers and editors through the electronic submission system. The Editorial Committee or the editor-in-chief may entrust an statistical expert with statistical review of articles at the final stage of review, and ask authors to revise their manuscripts, if necessary.

The acceptance for publication is decided by the Editorial Committee after its thorough review process, and the editor-in-chief will deliver an official approval of acceptance for publication.

6. COPYRIGHT

Once publication of the manuscript has been decided, the copyright will be deferred to the Korean Society for Health Promotion and Disease Prevention, and the copyright of the manuscript published will belong to the Society. The Society is entitled to publish, distribute and print a manuscript in the journal or other media. As the time of submission, a corresponding author, on behalf of all authors, must sign and submit the 'copyright transfer agreement form', which must be downloaded from the homepage, to confirm that its copyright is assigned.

7. ETHICAL REGULATIONS

Review and handling procedures related to all research ethics including ethics regulations and plagiarism, duplicate publication, and research misconduct will be followed according to the 'Good Publication Practice Guidelines for Medical Journals (http://kamje.or.kr/)' stipulated by the Korean Association of Medical Journal Editors (KAMJE).

1) Ethical Review and Informed Consent

If the research involves human participants, it must comply with the ethical standards of the Declaration of Helsinki (adopted in 1964; amended in 2008; https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/) and in principle must undergo scrutiny of an independent Institutional Review Board (IRB) or Research Ethics Committee (REC) which reviews the ethical issues of the human experiment. However, in clinical studies, the approval of the IRB or ERC and participant's consent must be received and specified in the text.

2) Privacy and Confidentiality

Every author must protect privacy and confidentiality of study participants. The personal information regarding the identity of a study participant must not be disclosed in any form: article, photo or pedigree. However, if a study participant's personal information is indispensable as scientific information, it must be explained to the study participant or his/her legal guardian, written informed consent should be obtained from him/her before publication, and his/her approval must be specified in a published article. At the time of explanation, a manuscript to be published, including photos, must be offered to a study participant and be approved by him/her. Description materials including photographs should not disclose study participant's name, english initials, and hospital identification number.

3) Redundant Publication/Duplicate Submission

An article that has been already reported in another journal or is being reviewed by another journal, and an article that has a redundant material previously published in the journal will be rejected. If the article contains similar work that has already been reported in another publication or has been published in the journal, the author should include copies of such material along with the submitted article. The Editorial Committee will decide on the matter of secondary publication of the submitted article and then consider for its acceptance. Also, the author can not submit a published article to another journal without authorization. Only under the conditions for secondary publication stipulated in the 'Uniform Requirements for Manuscripts Submitted to Biomedical Journals' this may be allowed.

4) Authorship and Contributorship

Every author must meet the authorship standards set forth in the 'Uniform Requirements for Manuscripts Submitted to Biomedical Journals'. He/she has a duty of verifying that his/her article has not yet been published and is not the same as any existing one. All persons designated as authors must fulfill all three conditions that they had contributed to 1) conception and design, acquisition of data, or analysis and interpretation of data, 2) drafting the article or revising it critically for important intellectual content, and 3) final approval of the version to be published. All contributors participating in the research not meeting the authorship standards must be listed in 'Acknowledgments' section after receiving their permission. After a manuscript has been submitted, no author could not be added.

5) Conflicts of Interest and Financial Disclosures

Each author has a duty to disclose direct or indirect conflicts of interest in the subject matter discussed in the submitted article. All authors must reveal all possible conflicts of interest that related to research such as consultation fees and stocks when submitting their article and should provide all of their personal signatures to verify that they have revealed so. A financial grant or support received for research purposes should be disclosed at the bottom of the title page, and all conflicts of interest such as consulting fees and stocks associated with study should also be disclosed at the bottom of the title page or in acknowledgment section. The corresponding author is required to confirm whether his/her or his/her co-authors have any conflict of interest to declare, and to provide appropriate details to the Editorial Committee.

8. RESUBMISSION

The resubmission period for a manuscript sent to its author for revision must be three months, and if three months are exceeded, the manuscript must be judged again as a new manuscript.

9. PAGE PROOFS

Page proofs will be sent to corresponding authors by the Editorial Committee. Authors must send them back within 48 hours after reading them carefully and revising them if necessary. The revision of page proofs must be limited to the errors of typesetting, and it is prohibited to change or to add new contents to the article. Authors are responsible for the contents of page proofs.

10. ARTICLE PROCESSING CHARGE

No review fees are charged for all the submitted articles. Article processing charges are required for publication in the *KJHP*. Publication fees for all the accepted original or review articles are 300,000 Korean Won (250 US dollars). Additionally, if the article exceeds 6 pages of the journal, additional fees (50,000 Korean Won or 40 US dollars per extra page) will be charged.

11. CORRECTIONS

If necessary, requests to publish corrections should be sent to the Editorial Committee within one month of journal publication. Corrections are reviewed by editors and authors and published in the next issue of the journal.

Copyright Transfer Agreement

Manuscript Title: ____

____

____

Authors: ____

____

____

On behalf of all authors of the manuscript entitled as above, I, as a corresponding author, certify that this article is an original work and that none of the material in the manuscript has been published previously or will be published. The authors warrant that they have obtained permission from the copyright holder to reproduce any materials and media including printed and electronic forms not owned by the authors, and that they have acknowledged the source.

Also, all the authors of this manuscript declare that there is no commercial association (e.g., financial interest, stock ownership, consultancy, patent and licensing agreement, etc.) that might pose a conflict of interest in relation to the submitted manuscript.

On behalf of all the authors, I hereby transfer, convey, and assign all copyrights in the Article to the *Korean Journal of Health Promotion* (*KJHP*). Also, the copyright to the Contribution identified above is transferred to the *KJHP*. The copyright transfer covers the right to print, publish, distribute, and sell throughout the world the said Contribution and parts thereof, including all revisions or versions and future editions, in all forms and media expression – such as in its electronic form (offline, online) – now known or developed in the future, as well as to translate, print, publish, distribute, and sell the Contribution in any foreign languages and throughout the world.

Name of Corresponding Author: ____

Signature of Corresponding Author on behalf of All Authors: ______________________________

Date: ________/________/________