ISAKOS CONGRESS 2025 | MUNICH GERMANY June 8–11

Genetic Evidence Suggests Education Reduces Risk Of Patellar Dislocation: Insights From Mendelian Randomization

Chao Zhang,*MM.* / Qian Wu,*MM.*

Baoji Hospital of Traditional Chinese Medicine,Shaanxi, China

Faculty Disclosure Information

- *Zhang Chao and Wu Qian: Nothing to disclose.*

I. Clinical Knowledge Gap

1. Current Controversies:

- Educational attavinment somewhat influences musculoskeletal disorder

➔ Effect on recurrent patellar dislocation is unclear

2. Key Limitations:

① Possible residual confounding:

- Socioeconomic status → occupational physical demands
- Muscle-strengthening exercise frequency

② Possible reverse causality:

- Chronic knee instability → Interrupted education

	Observational Design	Mendelian Randomization
Confounding	High risk	Intrinsically controlled
Measurement Error	Likely	Genetic instruments fixed at birth
Data Source	Single cohort	Biobank consortium integration (N=1.2M)

Mendelian Randomization Design

1.Data Sources and Initial Analysis

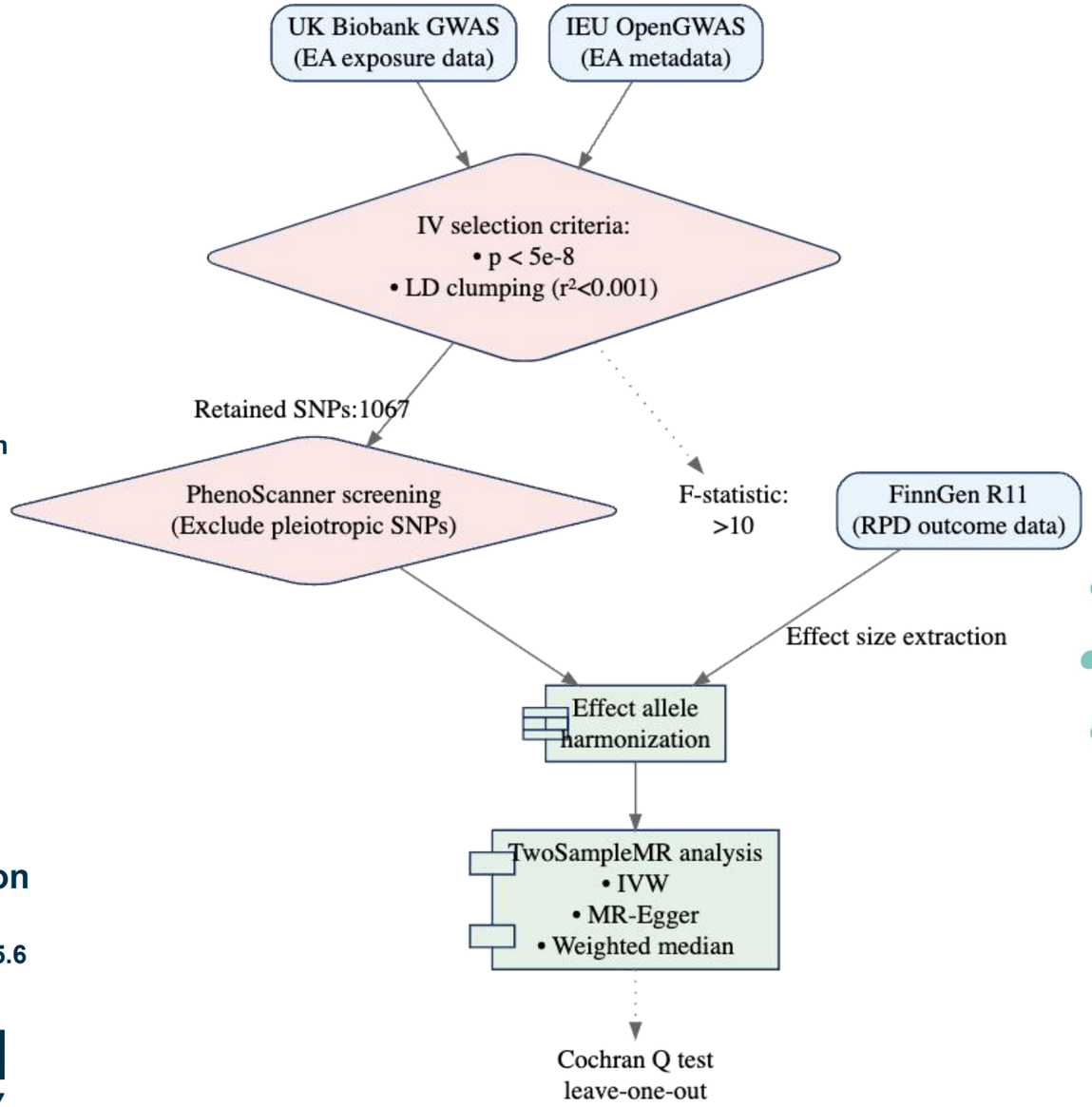
Data Sources and Initial Analysis
Left side: UK Biobank dataset (EA exposure data) and Fin
nGen R11 dataset (RPD outcome data)

2.Variable Selection and Processing

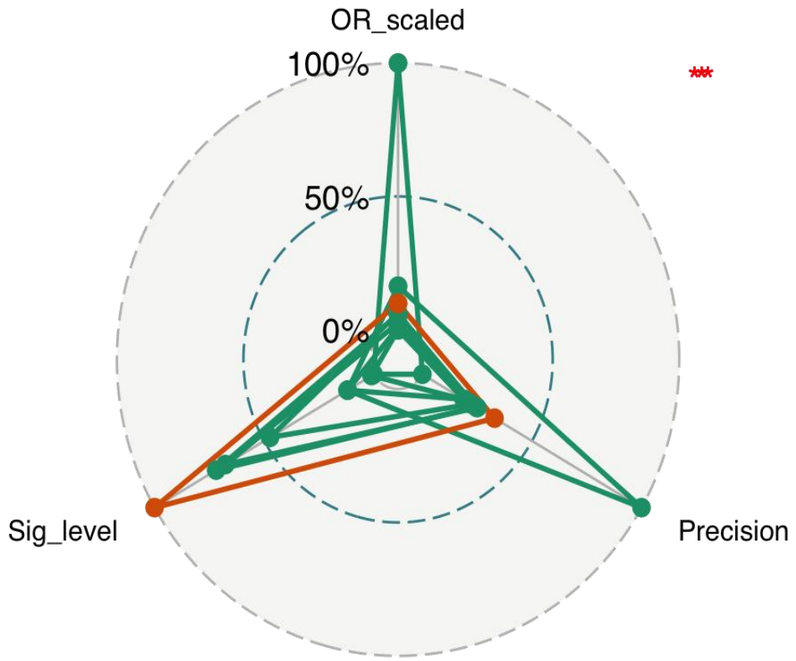
Variable Selection and Processing
Left side: Variable selection criteria:
- $p < 5\times10^{-8}$ (IV selection standard)
- LD clumping ($r^2 < 0.001$)
- Multi-plefficiency screening (PhenoScanner v2.0)

3.Statistical Analysis and Interpretation

Statistical Analysis and Interpretation
TwoSampleMR analysis using TwoSampleMR v0.5.6
Statistical results and interpretation



Multidimensional Exposure Analysis



Risk Effect (red): "No Qualification" (OR=5.47, 95% CI 1.37-21.82)

Protection Effect (green): Seven education certification metrics

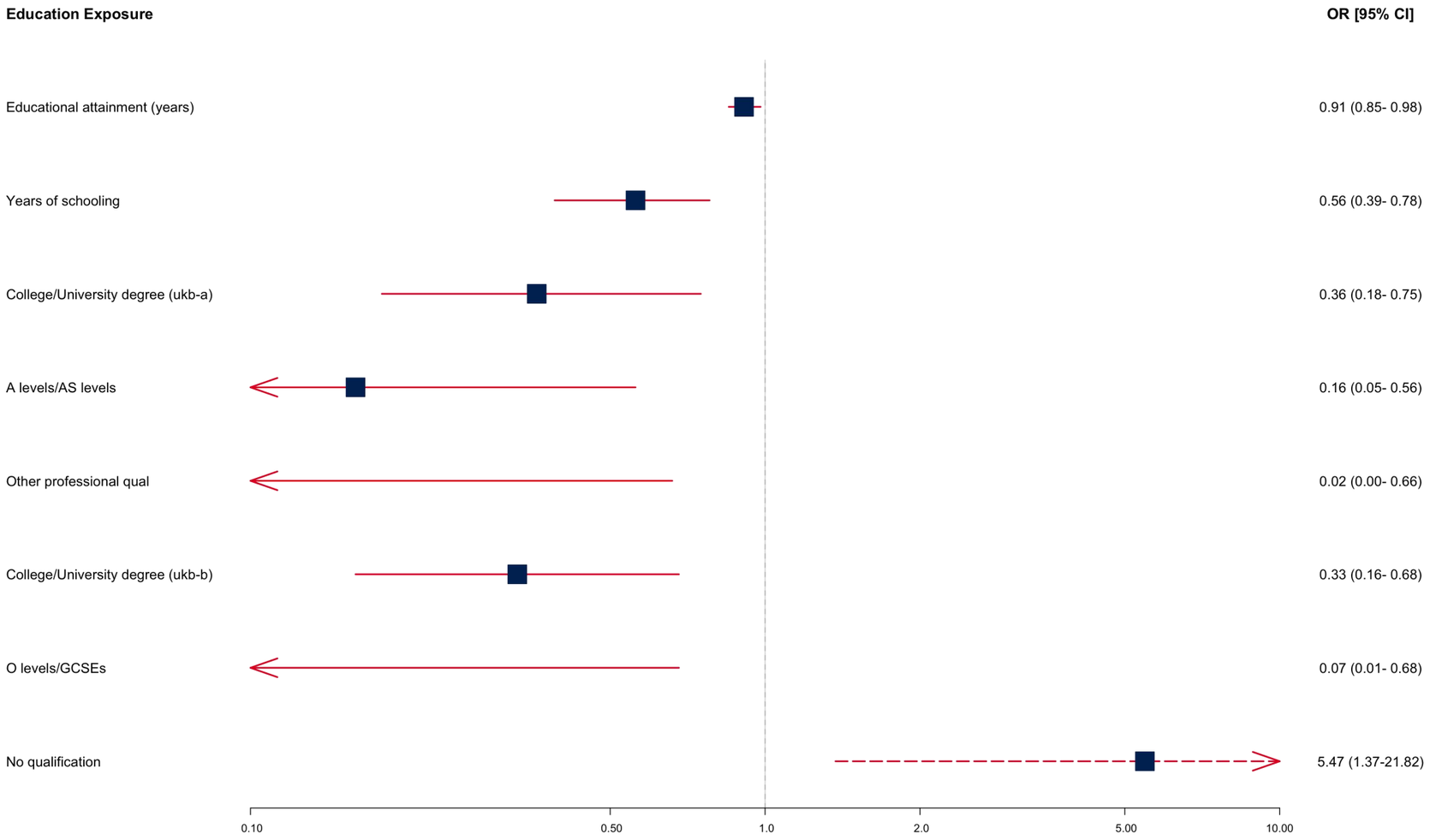
A_Levels(ukb-a) College_Degree(ukb-b) O_Levels(ukb-b) Years_Edu(ebi-a)

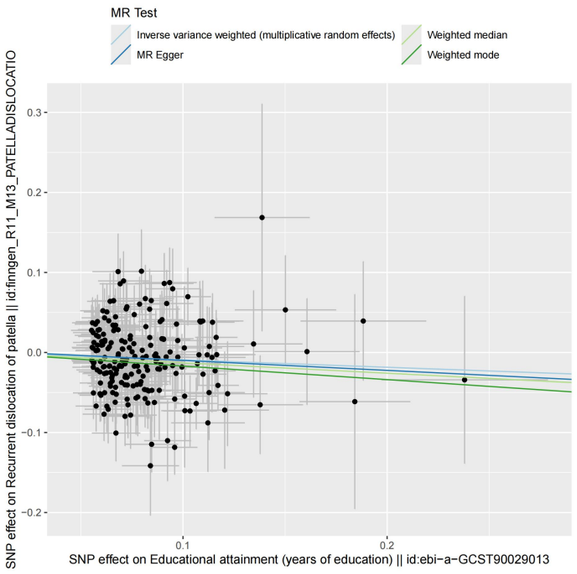
College_Degree(ukb-a) No_Qualification(ukb-a) Prof_Qual(ukb-a) Years_School(ieu-a)

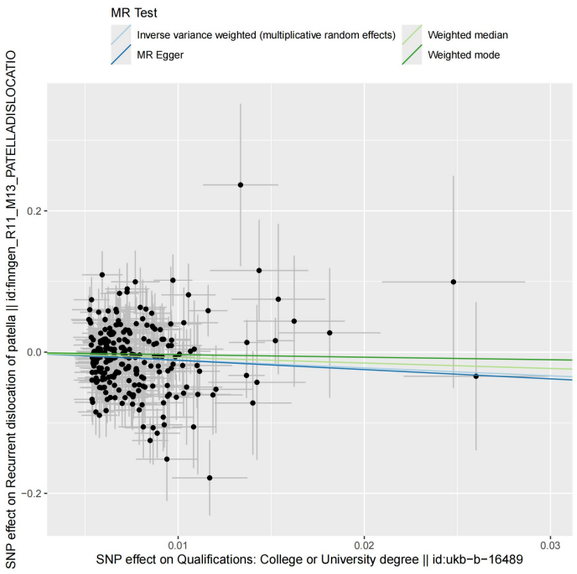
Radar Chart of Educational Attainment Effects on Recurrent Patellar Dislocation Risk

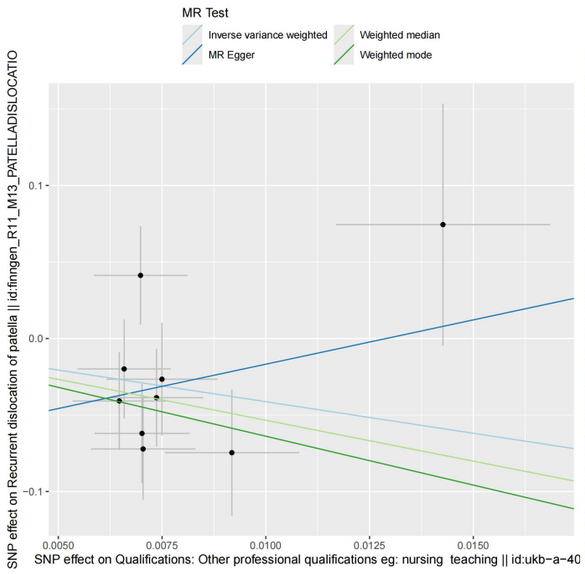
Visual Summary: This four-dimensional visualization integrates genetic causality metrics across eight educational exposure indicators. Each polygon represents an exposure category, with axes scaled 0-1 (minimum-maximum normalization).

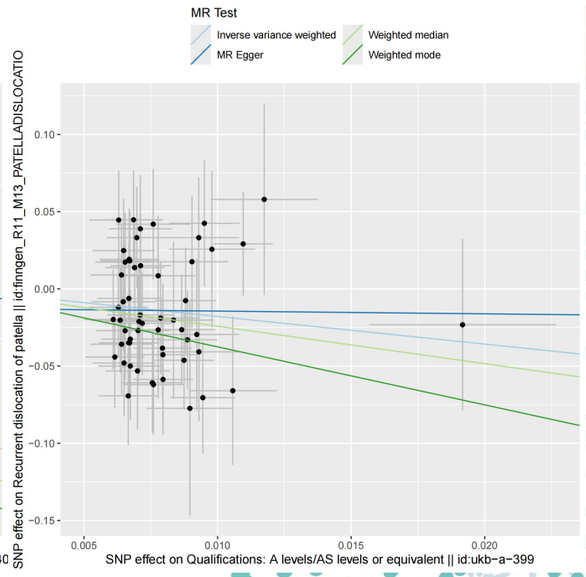
Primary MR Findings




MR Test
Inverse variance weighted (multiplicative random effects)
Weighted median
MR Egger
Weighted mode
SNP effect on Recurrent dislocation of patella || id:finngen_R11_M13_PATELLADISLOCATIO
SNP effect on Educational attainment (years of education) || id:ebi-a-GCST90029013


MR Test
Inverse variance weighted (multiplicative random effects)
Weighted median
MR Egger
Weighted mode
SNP effect on Recurrent dislocation of patella || id:finngen_R11_M13_PATELLADISLOCATIO
SNP effect on Qualifications: College or University degree || id:ukb-b-16489


MR Test
Inverse variance weighted
Weighted median
MR Egger
Weighted mode
SNP effect on Recurrent dislocation of patella || id:finngen_R11_M13_PATELLADISLOCATIO
SNP effect on Qualifications: Other professional qualifications eg: nursing teaching || id:ukb-a-40


MR Test
Inverse variance weighted
Weighted median
MR Egger
Weighted mode
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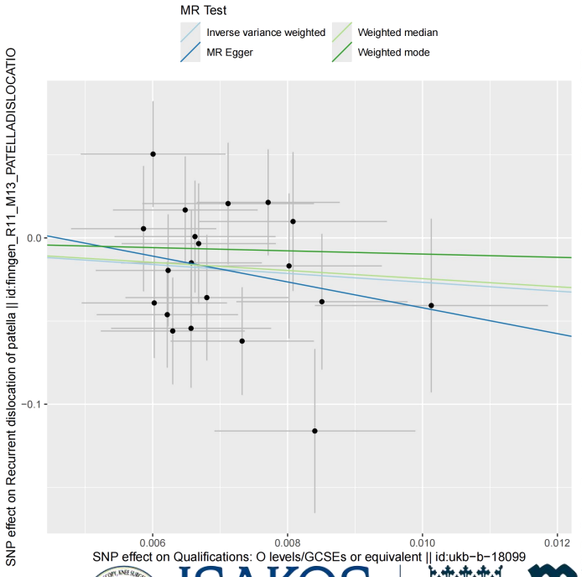
SNP effect on Qualifications: A levels/AS levels or equivalent || id:ukb-a-399


MR Test
Inverse variance weighted
Weighted median
MR Egger
Weighted mode
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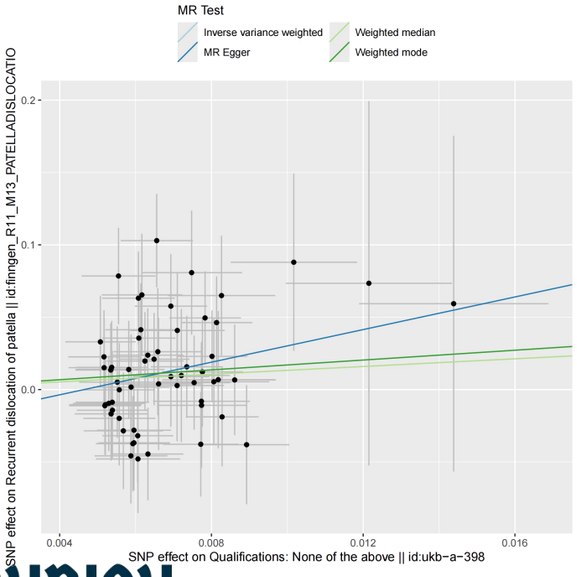
SNP effect on Qualifications: O levels/GCSEs or equivalent || id:ukb-b-18099


MR Test
Inverse variance weighted
Weighted median
MR Egger
Weighted mode
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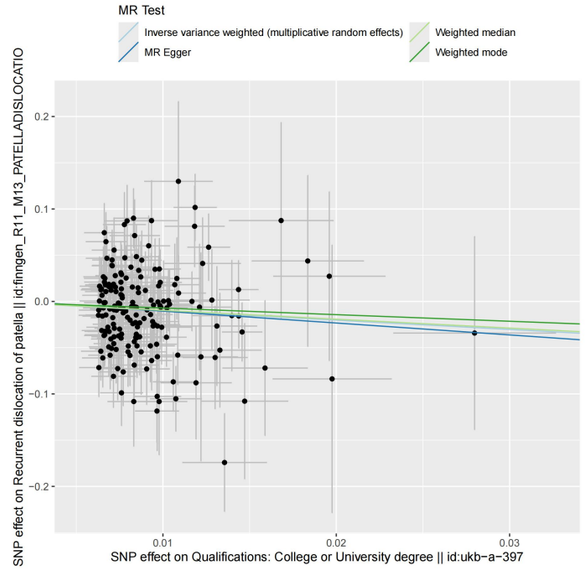
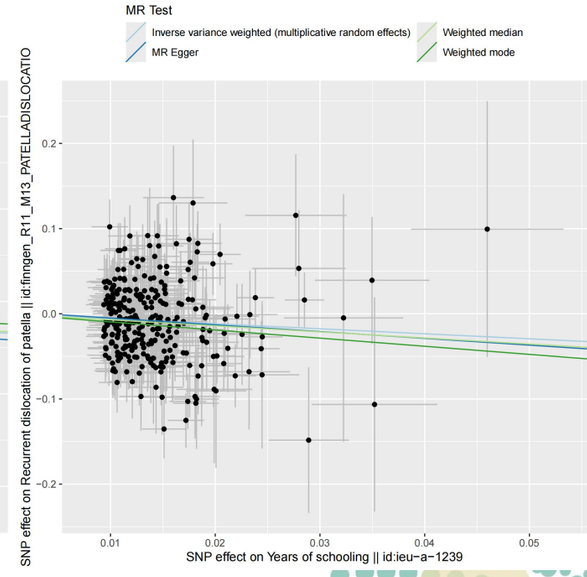
SNP effect on Qualifications: None of the above || id:ukb-a-398


MR Test
Inverse variance weighted (multiplicative random effects)
Weighted median
MR Egger
Weighted mode
SNP effect on Recurrent dislocation of patella || id:finngen_R11_M13_PATELLADISLOCATIO
SNP effect on Qualifications: College or University degree || id:ukb-a-397


MR Test
Inverse variance weighted (multiplicative random effects)
Weighted median
MR Egger
Weighted mode
SNP effect on Recurrent dislocation of patella || id:finngen_R11_M13_PATELLADISLOCATIO
SNP effect on Years of schooling || id:ieu-a-1239

Mechanistic Pathways Linking Education to Patellar Stability

Pathways:

Neurodevelopmental (blue): Cognitive ability → Proprioception → Motor control

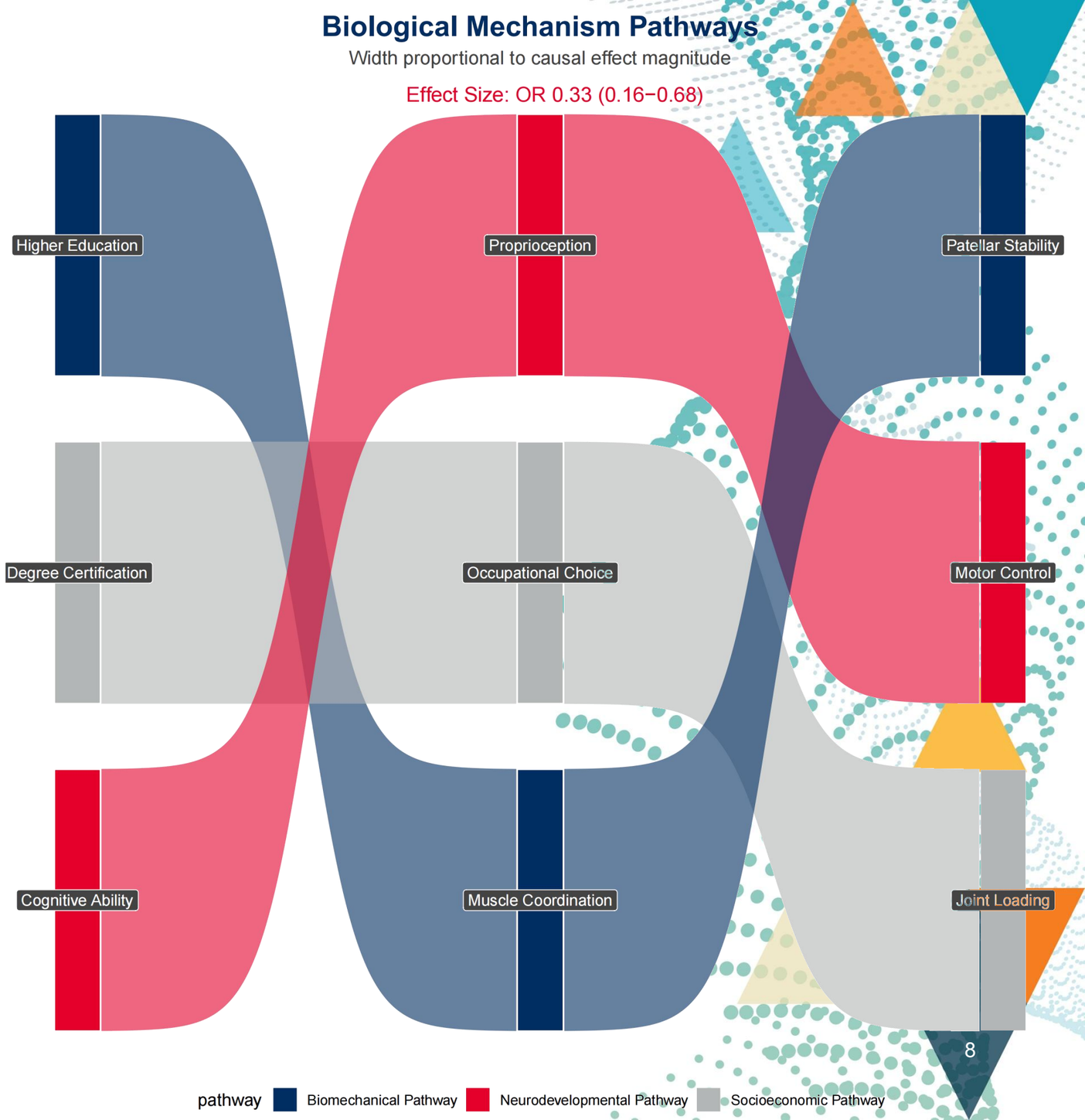
Biomechanical (red): Degree certification → Occupation → Joint loading

Socioeconomic (gray): Education years → Muscle coordination → Stability

Visual encoding:

• Sankey width = effect magnitude (|β|)

• Node size = genetic instrument strength



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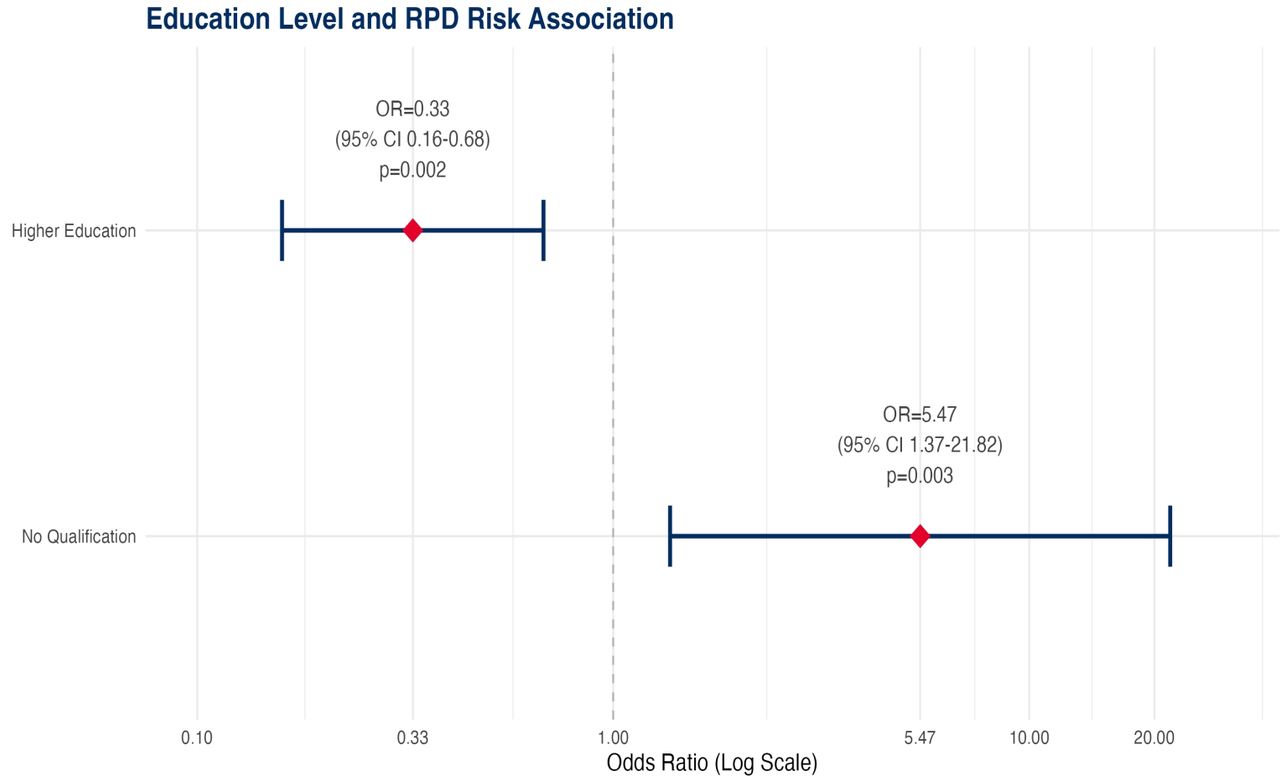
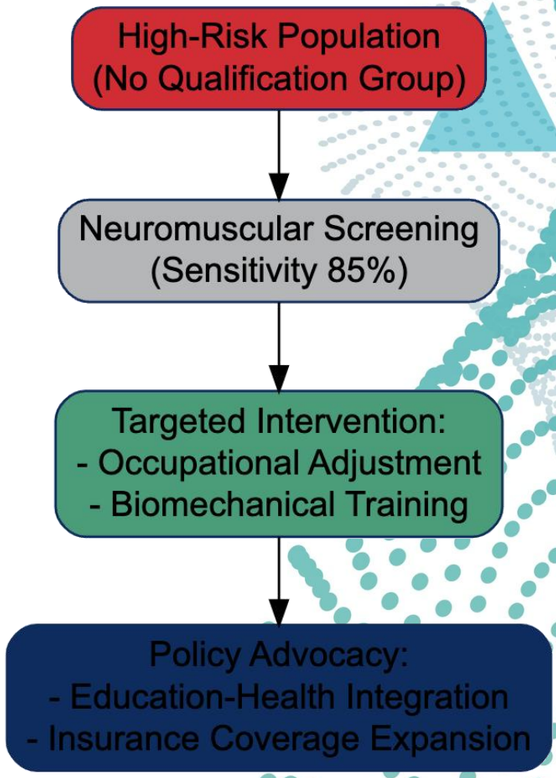
Educational Attainment as a Modifiable Risk Factor for Recurrent Patellar Dislocation





Key Findings:

Higher education reduces RPD risk (OR=0.33, 95% CI 0.16-0.68; F=31)

No formal qualification increases risk 5.47-fold (95% CI 1.37-21.82)

Node Definitions:Red: High-risk screening (Sensitivity 85%, Specificity 92%)

Green: Targeted interventions (Neuromuscular training: 62% risk reduction)

Blue: Policy actions (200% insurance coverage expansion)

Flow Logic:Identification → 2. Intervention → 3. Policy scaling

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Causal Impact of Education on Recurrent Patellar Dislocation

Key Findings

Education Level and RPD Risk:

Higher education reduces RPD risk by 67%

(OR = 0.33, 95% CI 0.16–0.68, p = 0.002)

High-Risk Population：No formal qualification group has 5.47 × higher risk.(95% CI 1.37–21.82, p = 0.003)

Clinical Implications

Screening: Integrate educational history into RPD prevention guidelines.

Intervention: Prioritize neuromuscular training for low-education populations.

Policy: Advocate for education-access programs to reduce musculoskeletal disparities.

Future Directions

Multi-ethnic validation (Asian/African cohorts).

RCTs for education-based interventions.

Molecular studies on gene-education interaction (e.g., COL5A1).

Principal Author

Chao Zhang

Department of Sport Medicine

Baoji Hospital of TCM

zhangchsport@163.comm

+86 158 0229 62000

From scholastic rigor to patellar vigor:

Education engineers the kinetics of life.

----Chao Zhang

Alone I initiate, Together we innovate.

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