Fat-to-muscle mass ratio, a novel anthropometric index, is associated with cardiometabolic risk: evidence from the China National Health Survey

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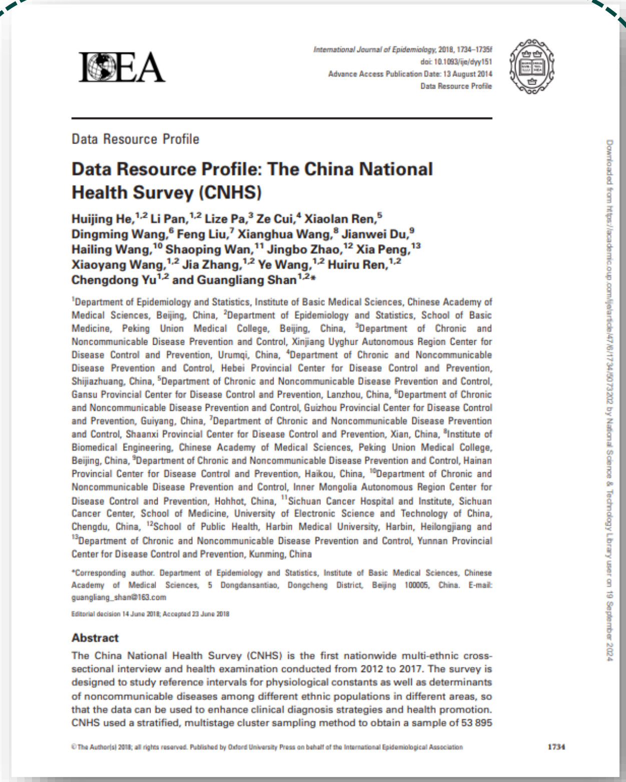
China National Health Survey (CNHS)

- Nationwide, Multi-Ethnic Survey
  - Covered 14 ethnic groups across 17 provinces (2012-2024)
- Sampling Method
  - Stratified, multistage cluster sampling
- Sample Size
  - Over 100,000 participants (aged above 20 years)
- Comprehensive Data
  - Demographics, socioeconomic, anthropometrics, lifestyle, blood samples, clinical profiles



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Data Resource Profile

Data Resource Profile

Data Resource Profile: The China National Health Survey (CNHS)

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Abstract

The China National Health Survey (CNHS) is the first nationwide multi-ethnic cross-sectional interview and health examination conducted from 2012 to 2017. The survey is designed to study reference intervals for physiological constants as well as determinants of noncommunicable diseases among different ethnic populations in different areas, so that the data can be used to enhance clinical diagnosis strategies and health promotion. CNHS used a stratified, multistage cluster sampling method to obtain a sample of 53 895

Data profile: CNHS

Huijing He, et al. *Int J Epidemiol*. 2018.

Background

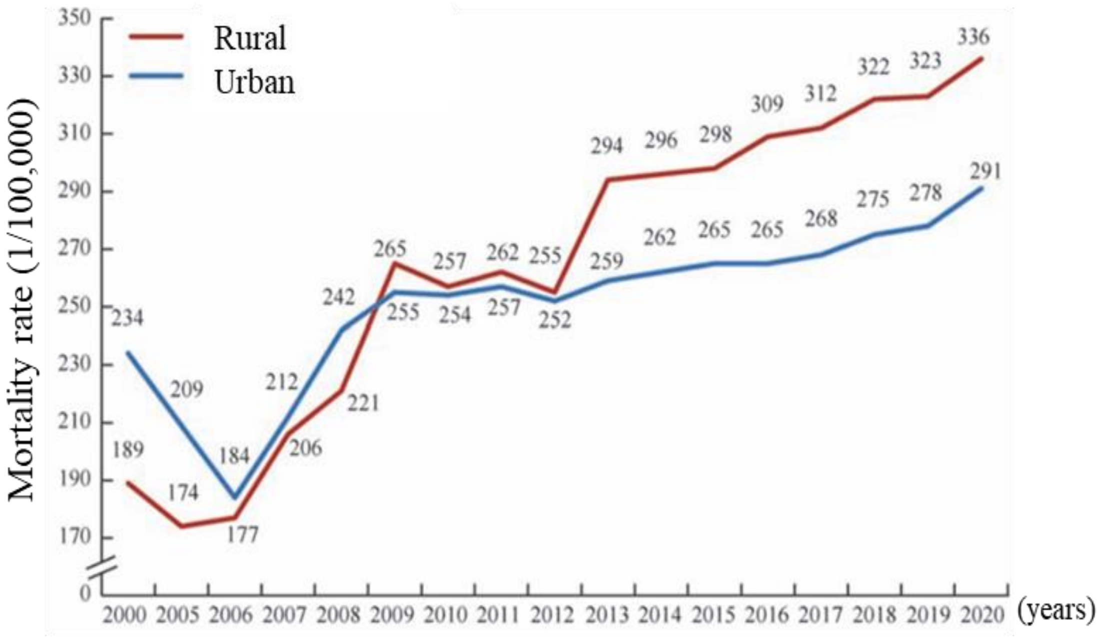


Fig.1 Changes of cardiovascular disease mortality in urban and rural residents in China from 2000 to 2020

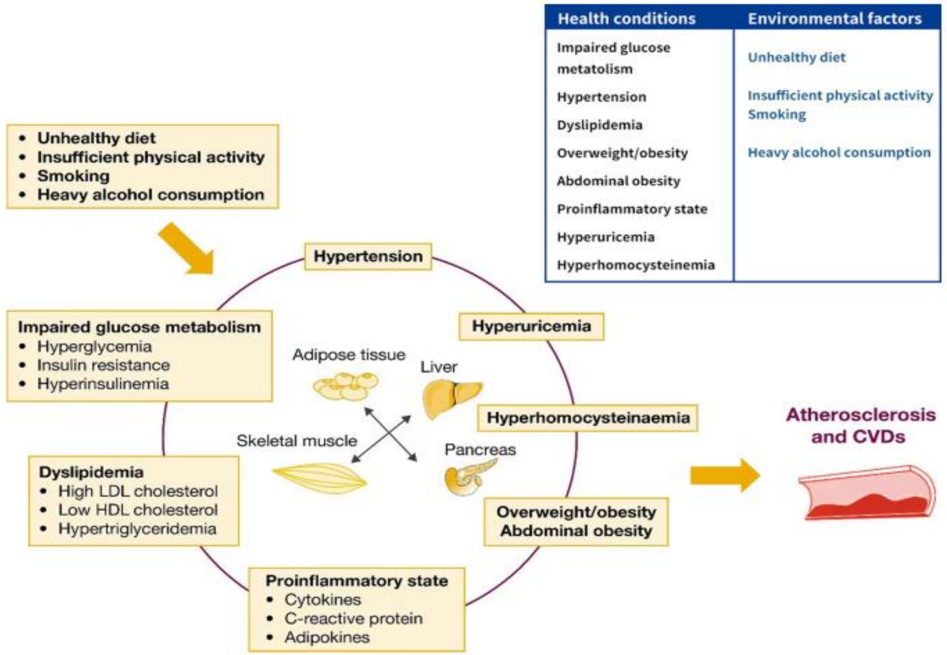


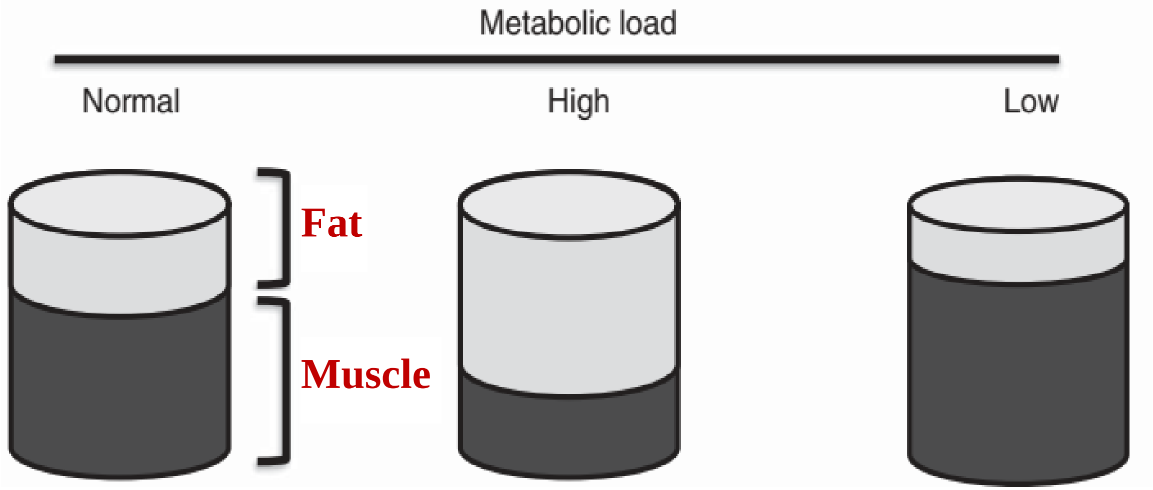
Fig.2 Interactive network of cardiometabolic risk factors

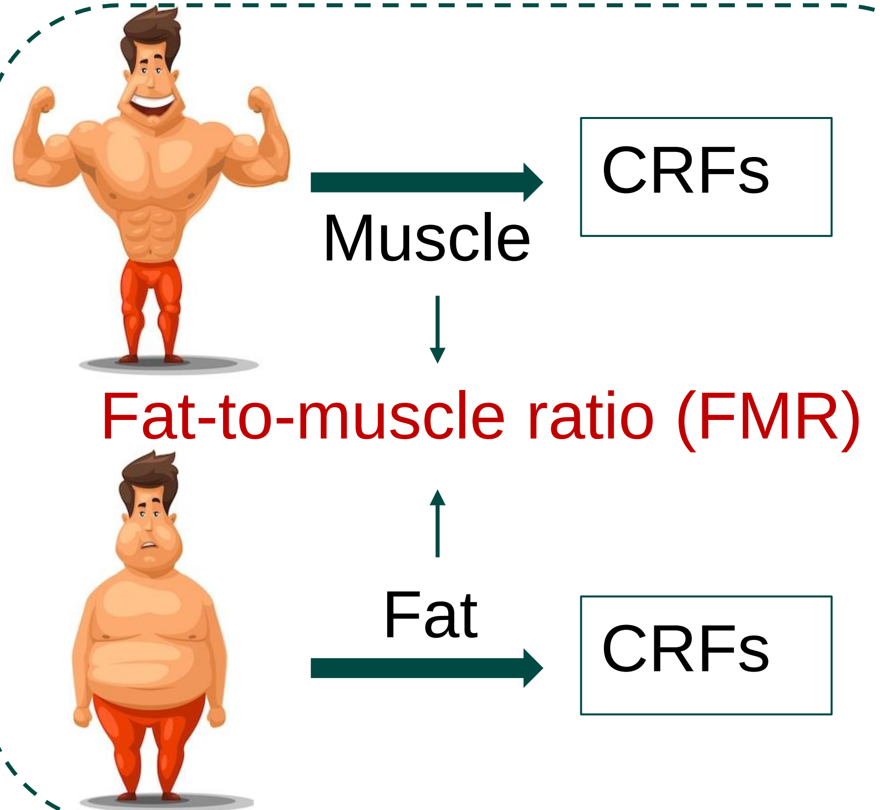
- Cardiovascular disease (CVD) is the leading cause of death in China.
- Cardiometabolic risk factors (CRFs) are modifiable risk factors for CVD.

China Cardiovascular Health and Disease Report 2022. *Chin J Cardiol*,2023.

Background

- Cardiometabolic Load-Capacity model
  - Fat tissue as a "metabolic load"
  - Muscle tissue as a "metabolic capacity"





Research question: FMR at different body sites predict single and clustered CRFs?

Mario,et al. *Public health nutri*,2014.
Bosy-Westphal A, et al. *Eur J Clin Nutr,* 2018.

Method

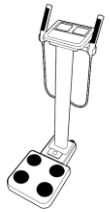
Study design

Cross-sectional study (CNHS 2023, including 3 provinces in China)

13,505 participants aged ≥20 years (5,208 men and 8,297 women)

Measurements

Fat mass and muscle mass →



Bioelectrical impedance analysis
Tanita MC780MA, Japan

Elevated Blood glucose
Dyslipidemia
Hyperuricemia
Insulin resistance
Hypertension →

Beckman AU5821, USA

Omron HEM-907, Japan

Method

Definition

FMR: fat mass/muscle mass → Whole body | Arm | Leg | Trunk

Clustered CRFs: ≥ 2 risk factors

Statistical analysis

FMR was classified into quartiles (Q1-Q4)

Sex-stratified analyses performed

Adjusted multivariable logistic regression models were used to estimate ORs and 95% CIs

Restricted cubic splines (RCS) was used to explore the nonlinear association

SAS software (version 9.4) was used to perform analyses

Results

1. The effects of FMRs on single CRFs

Quartile of FMR	Hypertension	Elevated blood glucose	dyslipidemia	Insulin resistance	Hyperuricemia
Men					
Whole body					
Q1(lowest)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Q2	1.96 (1.64, 2.33)	1.25 (1.02, 1.53)	2.44 (2.07, 2.88)	2.76 (2.20, 3.47)	1.98 (1.65, 2.38)
Q3	3.03 (2.53, 3.61)	1.86 (1.53, 2.56)	3.25 (2.75, 3.84)	4.14 (3.31, 5.17)	2.74 (2.28, 3.29)
Q4(highest)	5.28 (4.39, 6.34)	2.33 (1.92, 2.83)	4.15 (3.50, 4.91)	5.47 (4.39, 6.82)	4.11 (3.42, 4.93)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001
Arm					
Q1(lowest)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Q2	2.06 (1.73, 2.45)	1.39 (1.14, 1.71)	2.00 (1.70, 2.35)	2.36 (1.90, 2.94)	1.75 (1.47, 2.10)
Q3	2.92 (2.44, 3.48)	1.96 (1.61, 2.39)	2.78 (2.36, 3.28)	3.88 (3.14, 4.81)	2.41 (2.01, 2.88)
Q4(highest)	5.35 (4.46, 6.43)	2.49 (2.04, 3.02)	3.36 (2.85, 3.97)	4.41 (3.57, 5.46)	3.75 (3.13, 4.49)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001
Leg					
Q1(lowest)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Q2	1.85 (1.55, 2.21)	1.47 (1.20, 1.79)	2.43 (2.06, 2.86)	2.82 (2.23, 3.57)	2.10 (1.75, 2.53)
Q3	3.00 (2.51, 3.58)	1.86 (1.53, 2.27)	3.55 (3.01, 4.20)	4.56 (3.63, 5.72)	2.65 (2.20, 3.18)
Q4(highest)	5.48 (4.56, 6.59)	2.53 (2.08, 3.07)	4.37 (3.69, 5.18)	6.22 (4.97, 7.79)	4.25 (3.54, 5.10)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001
Trunk					
Q1(lowest)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Q2	1.90 (1.60, 2.27)	1.24 (1.02, 1.52)	2.31 (1.96, 2.71)	2.53 (2.03, 3.17)	1.90 (1.58, 2.28)
Q3	2.87 (2.41, 3.43)	1.86 (1.53, 2.26)	3.17 (2.69, 3.75)	3.94 (3.17, 4.90)	2.68 (2.24, 3.21)
Q4(highest)	4.92 (4.10, 5.91)	2.24 (1.85, 2.72)	3.96 (3.35, 4.69)	4.84 (3.90, 6.01)	3.92 (3.27, 4.70)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001

Quartile of FMR	Hypertension	Elevated blood glucose	dyslipidemia	Insulin resistance	Hyperuricemia
Women					
Whole body					
Q1(lowest)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Q2	1.60 (1.36, 1.88)	1.25 (1.03, 1.53)	1.46 (1.27, 1.68)	2.52 (2.10, 3.03)	1.60 (1.33, 1.93)
Q3	2.10 (1.80, 2.46)	1.74 (1.44, 2.10)	1.92 (1.67, 2.20)	3.71 (3.11, 4.43)	2.49 (2.08, 2.98)
Q4(highest)	3.29 (2.82, 3.85)	2.47 (2.06, 2.96)	2.42 (2.11, 2.78)	5.10 (4.28, 6.07)	3.92 (3.29, 4.67)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001
Arm					
Q1(lowest)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Q2	1.67 (1.42, 1.96)	1.23 (1.01, 1.50)	1.51 (1.32, 1.73)	2.07 (1.74, 2.47)	1.62 (1.34, 1.95)
Q3	2.15 (1.84, 2.52)	1.73 (1.44, 2.09)	1.82 (1.59, 2.08)	3.25 (2.74, 3.85)	2.39 (2.00, 2.85)
Q4(highest)	3.33 (2.85, 3.90)	2.44 (2.03, 2.92)	2.33 (2.03, 2.67)	4.38 (3.70, 5.18)	3.91 (3.29, 4.66)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001
Leg					
Q1(lowest)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Q2	1.73 (1.47, 2.03)	1.31 (1.07, 1.60)	1.51 (1.32, 1.73)	2.28 (1.90, 2.73)	1.71 (1.42, 2.06)
Q3	2.32 (1.98, 2.72)	1.83 (1.52, 2.21)	2.05 (1.79, 2.35)	3.56 (2.99, 4.24)	2.42 (2.02, 2.90)
Q4(highest)	3.56 (3.04, 4.17)	2.47 (2.06, 2.97)	2.47 (2.15, 2.83)	4.84 (4.07, 5.75)	3.91 (3.28, 4.67)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001
Trunk					
Q1(lowest)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
Q2	1.49 (1.27, 1.75)	1.28 (1.05, 1.56)	1.50 (1.31, 1.72)	2.55 (2.12, 3.05)	1.68 (1.39, 2.03)
Q3	1.98 (1.70, 2.32)	1.78 (1.48, 2.15)	1.97 (1.72, 2.26)	3.66 (3.07, 4.37)	2.51 (2.09, 3.00)
Q4(highest)	3.17 (2.72, 3.70)	2.50 (2.08, 3.00)	2.43 (2.12, 2.79)	4.95 (4.15, 5.89)	3.99 (3.35, 4.76)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001

- ORs increased significantly for single CRFs with the per quartile increase of total and regional FMR (All *P* for trend < 0.05)

Results

2. The effects of FMRs on Clustered CRFs

Men

FMR → Clustered risk	OR(95%CI)
Whole body	7.42(6.21,8.88)
Arm	6.66(5.59,7.95)
Leg	8.54(7.12,10.24)
Trunk	6.71(5.56,8.02)

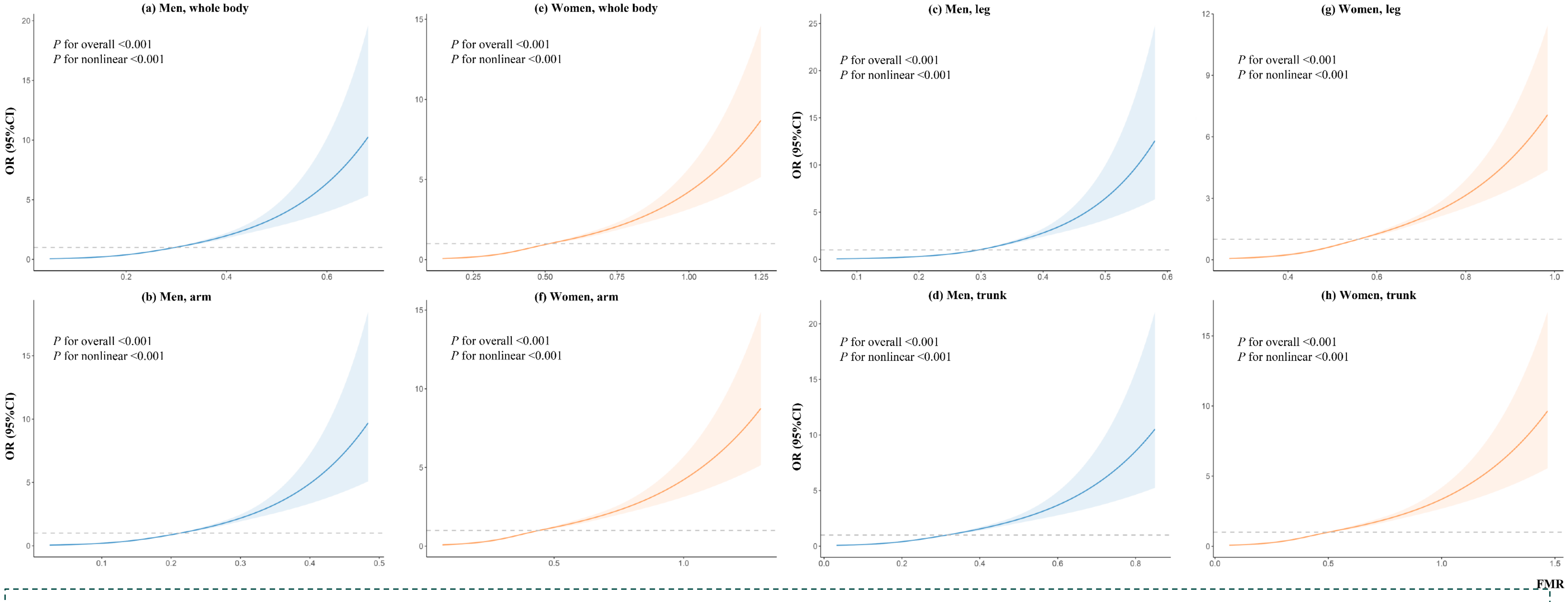
Women

FMR → Clustered risk	OR(95%CI)
Whole body	4.90(4.23,5.68)
Arm	4.62(3.99,5.35)
Leg	4.92(4.24,5.71)
Trunk	4.79(4.13,5.55)

- ORs increased significantly for clustered CRFs with the per quartile increase of total and regional FMR
- FMRs of the legs presented the strongest associations for clustered CRFs

Results

3. The non-linear associations of FMRs with Clustered CRFs



- RCS revealed significant non-linear relationships between FMRs of different body parts and clustered CRFs in both sexes

Discussion

Strengths

- Large sample size
- Whole body and body parts

Limitations

- Cannot be interpreted as a causal relationship
- Not measured with high precision by imaging techniques such as DEXA
- Limited generalizability

Conclusion

- Significant association: FMRs and single/clustered CRFS
- Support the development of targeted interventions to improve muscle and fat mass in specific body regions as a preventative measure for CRFs in clinical and public health settings.

Thanks!

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