Healthcare costs associated with micro- and macro-vascular complications among populations with metabolic syndrome: a nationwide analysis

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Background and objective

- Metabolic syndrome (MS) increases the risks of vascular complications. However, economic burden attributed by vascular consequences following remains uncertain.
- This study aimed to quantify the impact of vascular complications on healthcare costs among populations with MS.

Methods

- **Study flow**

MS population who fulfilled any 3 of following criteria were identified from 2013 NHIS:
(1) BMI ≥ 27 kg/m² (2) Diabetes (3) Hypertension (4) Hyperlipidemia

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2013 NHIS was linked to 2013-2019 Taiwan NHIRD to identify events of interest
- ✓ Macrovascular complications (i.e., cardiovascular and cerebrovascular diseases)
- ✓ Microvascular complications (i.e., retinopathy, nephropathy, and neuropathy or PVD)
- ✓ All-cause death

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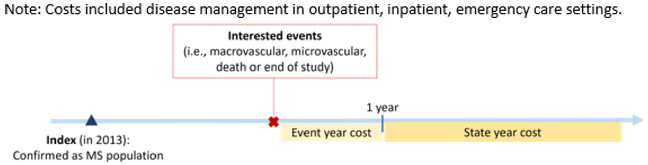
Annual healthcare costs associated with events of interest were calculated.
- ✓ Event-year cost: cost within the first year of event occurred
- ✓ State-year cost: average cost in the years following the event occurred
- ✓ Dead cost: cost within the year before death

Note: Costs included disease management in outpatient, inpatient, emergency care settings.



Abbreviations: MS, metabolic syndrome; NHIS, National Health Interview Survey; BMI, body mass index; NHIRD, National Health Insurance Research Database; PVD, peripheral vascular disease.

- **Statistical analyses**
  - ✓ Generalized estimating equation (GEE) was used to evaluate the impact (i.e., cost multipliers) of patient characteristics (e.g., comorbidities, complications) on annual healthcare costs.
  - ✓ Costs were presented as United States dollars (USD) in year 2021.

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Results: Baseline characteristics and crude costs

Table 1. Baseline characteristics of MS populations (n=854)

Characteristics	Mean (SD) or proportion
Sex (male) (%)	54.3
Age at the index date (years)	59.8 (12.8)
Comorbidities (%)	
BMI ≥ 27 kg/m²	65.0
Diabetes	74.9
Hypertension	93.7
Hyperlipidemia	91.3

Abbreviation: SD, standard deviation.

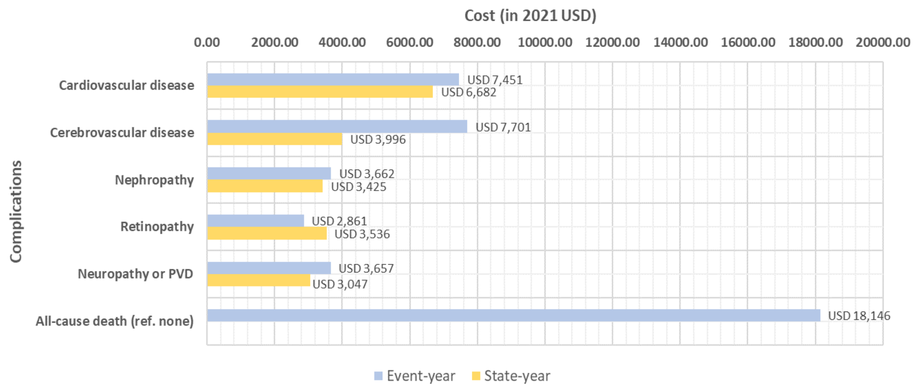

Figure 1. Mean values of crude event-year and state-year healthcare costs of MS-related complications

- The magnitude of increase in healthcare costs among MS populations were more substantial when cardiovascular (167%) and cerebrovascular diseases (100%) occurred compared to other clinical conditions (Table 2).

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Results: cost multipliers

Table 2. Cost multipliers of demographics, comorbidities, and MS-related complications with an illustrative example

A 60-years old man diagnosed with MS (BMI ≥ 27 kg/m², hypertension, and diabetes) developed a cardiovascular event*. Annual healthcare cost is estimated as below:

Variables	Multiplier (95% CI)	Illustration
Baseline annual health care cost (2021 U.S. $), mean (95% CI)	195 (117 , 327)	
Age at the index date	1.02 (1.01 , 1.02)	USD 195*(1.02)^{60}
Male (ref. female)	0.96 (0.87 , 1.06)	*0.96
Comorbidity (ref. none)		
BMI ≥ 27 kg/m²	1.02 (0.90 , 1.16)	*1.02
Hypertension	1.47 (1.13 , 1.90)	*1.47
Diabetes	1.39 (1.21 , 1.59)	*1.39
Hyperlipidemia	1.04 (0.86 , 1.25)	
Complication (event-year) (ref. none)		
Cardiovascular disease	2.67 (2.18 , 3.28)	*2.67
Cerebrovascular disease	2.00 (1.50 , 2.68)	
Nephropathy	1.26 (1.14 , 1.39)	
Retinopathy	1.24 (1.10 , 1.41)	
Neuropathy or PVD	1.30 (1.12 , 1.51)	
Complication (state-year) (ref. none)		
Cardiovascular disease	1.95 (1.59 , 2.39)	
Cerebrovascular disease	1.20 (0.94 , 1.52)	
Nephropathy	1.22 (1.10 , 1.35)	
Retinopathy	1.24 (1.08 , 1.43)	
Neuropathy or PVD	1.14 (0.99 , 1.32)	
All-cause death (ref. none)	1.94 (1.39 , 2.69)	

Calculation process:
USD 195* (1.02)^{60}*0.96 *1.02*1.47*1.39*2.67

Abbreviation: PVD, peripheral vascular disease.
*Note: (1) The analysis also adjusted other complications (e.g, cancer, acute metabolic complications) and other obesity-related conditions (e.g., sleep apnea, bariatric surgery , knee replacement). (2) Age of 60 years in illustrative example refers to mean age in Table 1.

Estimated annual healthcare cost=USD 3,418

Conclusion

- ✓ Effective strategies for prevention of developing vascular complications are urgently needed for people living with MS and thereby alleviate associated economic burden.
- ✓ Cost estimates from this study are useful for parameterizing future modeling-based economic evaluations of interventions in this population.