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Female Underweight/Undernutrition Syndrome (FUS): An Emerging Health Concept in Premenopausal Women - Secondary Publication (English Translation of the Japanese Statement)

Yoshifumi Tamura[1] | Wataru Ogawa[2] | Kojiro Ishii[3] | Yasushi Ishigaki[4] | Narumi Nagai[5] | Yushi Hirota[6] | Katsutaro Morino[7] | Mikako Inokuchi[8] | Tomohiro Suzuki[9] | Sakae Tanaka[10] | Masakazu Terauchi[11] | Sayaka Nose-Ogura[12] | on behalf of the Working Group on Female Underweight/Undernutrition Syndrome | The Japan Society for the Study of Obesity

[1]Department of Sports Medicine and Sportology/Department of Metabolism and Endocrinology, Juntendo University Graduate School of Medicine, Tokyo, Japan | [2]Section of Metabolic Diseases, Division of Translational Science, Kobe University Graduate School of Medicine, Kobe, Japan | [3]Faculty of Health and Sports Science, Doshisha University, Kyoto, Japan | [4]Division of Diabetes, Metabolism and Endocrinology, Department of Internal Medicine, Iwate Medical University, Yahaba, Japan | [5]School of Human Science and Environment, University of Hyogo, Himeji, Japan | [6]Division of Diabetes and Endocrinology, Department of Internal Medicine, Kobe University Graduate School of Medicine, Kobe, Japan | [7]Department of Diabetes and Endocrine Medicine, Graduate School of Medicine and Dental Science, Kagoshima University, Kagoshima, Japan | [8]Health Center, Keio University, Kanagawa, Japan | [9]School of Child Psychology, Tokyo Future University, Tokyo, Japan | [10]Department of Orthopaedic Surgery, Faculty of Medicine, The University of Tokyo, Tokyo, Japan | [11]Department of Women's Health, Institute of Science Tokyo, Tokyo, Japan | [12]Department of Sports Medicine, Japan Institute of Sports Sciences, Japan High Performance Sport Center, Tokyo, Japan

Correspondence: Yoshifumi Tamura (ys-tamur@juntendo.ac.jp)

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ABSTRACT

In Japan, approximately 20% of women in their twenties are underweight (BMI < 18.5 kg/m^2), representing one of the highest prevalences among developed nations. Underweight and undernutrition are associated with decreased bone mass, menstrual abnormalities, impaired glucose tolerance, sarcopenia-like changes, and systemic symptoms including depression and fatigue, significantly impacting health from young adulthood through the life course. This situation is influenced by complex factors including the societal internalization of thinness ideals, social media and mass media influences, the off-label use of GLP-1 receptor agonists, and socioeconomic factors such as poverty. However, while current healthcare and screening systems have advanced in addressing obesity, systematic approaches to underweight remain inadequately developed. Based on discussions by an expert working group established by the Japan Society for the Study of Obesity in collaboration with multiple related academic societies, this paper proposes a novel disease concept: Female Underweight/Undernutrition Syndrome (FUS). FUS encompasses the diverse physical and psychological health disorders arising from underweight or undernutrition, aiming to establish clear diagnostic criteria and frameworks for early detection and preventive intervention. Comprehensive measures are required, including stigma prevention, collaboration with educational and industrial sectors,

Working Group leadership: Wataru Ogawa (Chair); Yoshifumi Tamura (Vice-Chair).

Representatives from related academic societies: Mikako Inokuchi (The Japanese Society for Pediatric Endocrinology); Tomohiro Suzuki (The Japanese Psychological Association); Sakae Tanaka (The Japan Osteoporosis Society); Masakazu Terauchi (The Japan Society for Menopause and Women's Health); Sayaka Nose-Ogura (The Japan Society of Obstetrics and Gynecology).

integration into health screening systems, and addressing underlying social determinants. Through the proposal of FUS, we anticipate progress toward comprehensive interventions addressing the societal challenges surrounding women's health and body image.

1 | Introduction

Approximately 20% of Japanese women in their twenties are underweight (BMI < 18.5 kg/m^2), a prevalence notably high among developed nations [1]. Underweight and undernutrition are known to be associated with various health disorders affecting women's health, including decreased bone mass and menstrual irregularities. The high prevalence of underweight women in Japan is attributed to the deeply ingrained societal value of "thinness equals beauty" propagated through social networking services (SNS) and fashion magazines, fostering strong desires for thinness. Recently, the off-label use of GLP-1 receptor agonists, originally developed for diabetes and obesity treatment, has been promoted as an "easy weight loss method," becoming a significant social issue [2].

However, conventional medical systems and public health policies have prioritized obesity management, while systematic approaches to underweight and undernutrition remain insufficient. A primary reason is the absence of a disease concept that clearly articulates the relationship between underweight/undernutrition and disease. Furthermore, addressing this issue requires not only focusing on individual awareness and behavior but also approaching the social structures that generate desires for thinness.

Against this background, the Japan Society for the Study of Obesity established a working group in collaboration with the Japanese Osteoporosis Society, Japan Society of Obstetrics and Gynecology, Japanese Society for Pediatric Endocrinology, Japan Society for Menopause and Women's Health, and the Japanese Psychological Association. This working group aims to position the conditions of underweight and undernutrition accompanied by decreased bone mass, menstrual irregularities, and poor physical condition as a new syndrome while establishing diagnostic criteria and prevention guidelines and discussing solutions to these challenges. This statement organizes the issues surrounding the increase in underweight among premenopausal adult women, presents the nomenclature, definition, and stigma countermeasures for this new disease concept, and discusses improvement strategies.

2 | Background

2.1 | Current Status of Underweight Women in Japan and Life Course Implications

Underweight among Japanese women is particularly prominent in their twenties, with its prevalence notably high among developed nations. The proportion of underweight individuals was approximately 10% around 1980 but subsequently increased, with 20%–25% of women in their twenties classified as underweight since the 1990s [1]. Various studies have revealed that Japanese women tend to set excessively low ideal body weights and exhibit strong desires for thinness. For instance, body image distortion (overestimation) is associated with desires for thinness among adult women [3], and young underweight women perceive a BMI of 20.5 kg/m^2 as overweight, suggesting strict weight cognition and body image distortion [4]. While such underweight status may result from intentional dietary restriction, approximately 40% of underweight individuals have no history of dieting, suggesting many may be constitutionally thin [4].

Excessive underweight and undernutrition during young adulthood can affect crucial physical functions such as bone growth and reproductive development, potentially impacting the entire life course. For example, impaired bone formation during peak bone mass acquisition leads to increased future osteoporosis risk. Extreme weight loss and undernutrition may cause menstrual irregularities and infertility. Additionally, persistent nutritional deficiencies can lead to various health disorders from micronutrient and vitamin deficiencies, as well as metabolic abnormalities. Furthermore, muscle strength and mass may decrease even before reaching old age, potentially increasing the risk of progression to sarcopenia. These issues occurring in young adulthood affect health at each life stage, including decreased quality of life (QOL) in the medium to long term and increased frailty risk in old age, and may potentially compromise the health of future generations. Therefore, early appropriate approaches and prevention are essential.

2.2 | Health Risks and Symptoms Associated With Underweight and Undernutrition

2.2.1 | Decreased Bone Mass and Osteoporosis

Young adulthood represents the critical period for achieving peak bone density. However, undernutrition, decreased estrogen levels, and reduced mechanical loading due to low body weight impair bone formation, leading to bone loss in the twenties and increasing future osteoporosis risk [5].

2.2.2 | Menstrual Irregularities, Fertility, and Child Health Risks

Undernutrition and extreme weight loss affect the hypothalamic–pituitary-ovarian axis, causing menstrual irregularities and ovulatory dysfunction [6]. Long-term concerns include increased risks of infertility and pregnancy complications. Oligomenorrhea and hypothalamic amenorrhea associated with underweight, combined with poor pre-pregnancy physique and nutritional status, may affect child health, including increased risks of threatened preterm birth and low birth weight infants [7].

The recently highlighted concept of Developmental Origins of Health and Disease (DOHaD) emphasizes that maternal nutritional status during pregnancy influences the child's health throughout their life course. From this perspective, underweight and undernutrition in young women may increase future health risks for both mother and child [8].

2.2.3 | Health Disorders From Micronutrient and Vitamin Deficiencies

Undernutrition often leads to multiple vitamin and mineral deficiencies, potentially causing various health disorders [9]. Deficiencies in iron, folate, and vitamin B12 cause anemia [10], while zinc deficiency results in delayed wound healing, impaired immune function, and taste abnormalities [11]. Furthermore, vitamin D and calcium deficiencies lead to decreased bone mineral density (BMD), increasing risks of osteoporosis and fractures [12].

2.2.4 | Metabolic Abnormalities

Underweight is recognized as a risk factor for diabetes development, with recent research revealing that underweight young Japanese women have an increased risk of impaired glucose tolerance [13, 14]. Energy restriction also causes low T3 syndrome, characterized by decreased triiodothyronine (T3), a thyroid hormone regulating metabolism, and dyslipidemia (elevated LDL cholesterol) [15].

2.2.5 | Sarcopenia-Like State

While age-related loss of muscle mass and strength is defined as sarcopenia, associations with decreased muscle mass have been identified in underweight and undernourished young women [13]. Decreased muscle mass and strength raise concerns about future locomotive syndrome and frailty, making sarcopenia prevention during young adulthood important from the perspective of life course and geriatric health maintenance [16].

2.2.6 | Eating Disorders

In a social climate where desires for thinness are easily internalized, excessive dietary restriction may progress to eating disorders. Cases often become severe when combined with psychological stress and low self-esteem. Particularly among young women, internalization of ideal thin body images promotes abnormal eating behaviors, and combined with societal pressure for thinness including media influences, increases eating disorder risk [17].

2.2.7 | Psychological, Neurological, and Systemic Symptoms

Underweight and undernutrition cause physical symptoms including fatigue, sleep disorders, hypotension, headaches, constipation, cold sensitivity, and deterioration of skin and hair quality [18–20]. Neuropsychiatric symptoms include depression, anxiety, decreased concentration, cognitive impairment, and reduced physical activity [18, 21–23].

2.3 | Challenges in Current Systems

While specific health guidance is promoted for obesity management, frameworks for intervention in underweight remain unestablished. Even when underweight is identified during health examinations, screening for related conditions such as BMD and reproductive function assessment is rarely implemented. Additionally, appropriate dietary education and body image awareness for adolescent children in educational settings cannot be considered adequate.

2.4 | Off-Label Use of GLP-1 Receptor Agonists

Cases of GLP-1 receptor agonists, developed and approved for obesity and Type 2 diabetes, being marketed and used as "diet pills" have become commonplace, with reports of use by underweight and normal-weight women [24]. Such use raises social concerns including adverse effect risks and promotion of excessive dieting behaviors, leading to statements highlighting these issues [2].

3 | Concept of the Novel Syndrome

3.1 | Necessity and Considerations for Establishing the Disease Concept

The objective of this working group is to systematically organize health disorders related to underweight and undernutrition in premenopausal adult women and present them as a new concept (syndrome). In constructing this syndrome concept, we referenced the approach of metabolic syndrome.

Specifically, metabolic syndrome conceptualized, based on various evidence, that individual conditions such as hypertension, hyperglycemia, and dyslipidemia represent only the tip of the iceberg, with visceral obesity as the fundamental pathology. This conceptualization not only clarified intervention points but also made the pathology widely understandable, deepening individual-level recognition and serving as a catalyst for appropriate behavioral changes. Similarly, in proposing this disease concept, we focus on the fundamental pathology of underweight and undernutrition rather than solely on surface indicators such as anemia, menstrual irregularities, and fatigue, thereby constructing a more comprehensive framework for health risk assessment and intervention. This working group considers it important to understand structurally that FUS-related symptoms and diseases represent merely the tip of the iceberg, with constitutional, psychological, social, and socioeconomic factors underlying them (Figure 1). This figure visualizes the health disorders of FUS and their underlying factors as an "iceberg model." This is expected to be utilized not only in health examinations and clinical settings but also to be widely recognized by the general public. However, diseases and symptoms related to underweight are not necessarily limited to underweight

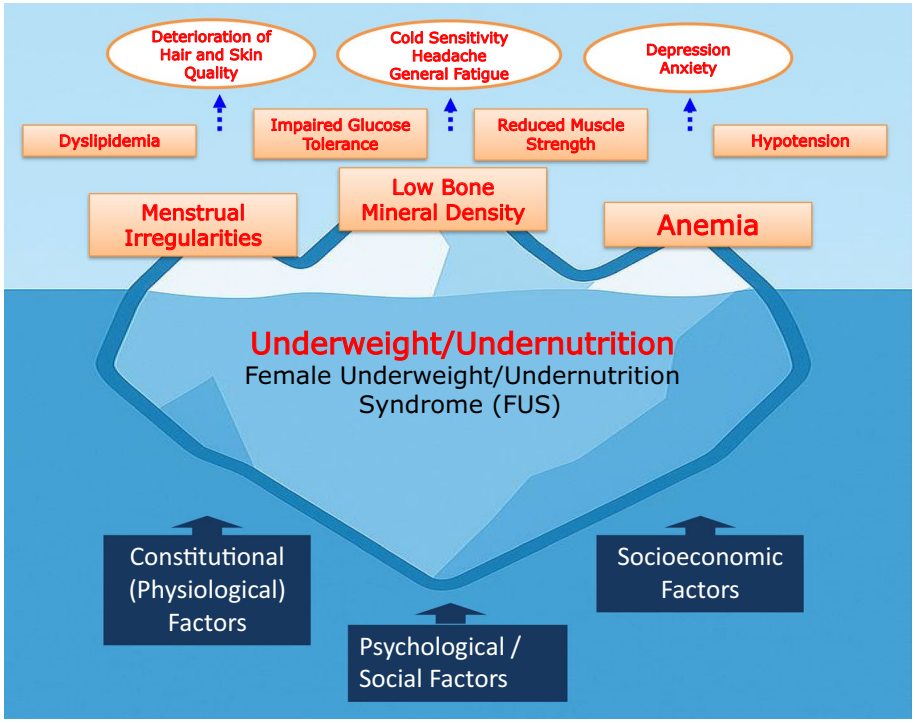

FIGURE 1 | Structural model of FUS (Female Underweight/Undernutrition Syndrome): manifest health disorders and diverse underlying factors. Health disorders associated with FUS (decreased BMD, menstrual irregularities, decreased muscle strength, depression, etc.) represent only the tip of the iceberg, with constitutional, psychological/social, and socioeconomic factors underlying them. A comprehensive understanding of the fundamental issues and multifaceted interventions is required. *Source:* Adapted from Working Group on Female Underweight/Undernutrition Syndrome, The Japan Society for the Study of Obesity. Health Issues Associated with Underweight and Undernutrition in Premenopausal Adult Women: Toward the Establishment of a Novel Syndrome. *Himan Kenkyu* (*Journal of the Japan Society for the Study of Obesity*) [2025;31:55–61. Japanese.], 2025 The Japan Society for the Study of Obesity. Reproduced/adapted with permission.

individuals and may also result from insufficient nutritional intake. Therefore, if underweight is made mandatory in the disease concept, it may create the misunderstanding that "there is no problem if one is not thin," requiring careful consideration in establishing the disease concept.

3.2 | Proposed Syndrome Name, Concept, and Definition

As shown in Figure 1, while FUS manifests diverse symptoms, multiple factors are complexly related in the background, requiring hierarchical understanding for concept construction. Based on this background, the working group proposes *Female Underweight/Undernutrition Syndrome (FUS)* as the name for the syndrome indicating the relationship between underweight/undernutrition and health disorders in women. For adult women aged 18 years and above until menopause, the main diseases and conditions included in FUS are as follows.

Undernutrition and body composition abnormalities:

- BMI < 18.5 kg/m^2
- Low muscle mass and decreased muscle strength.
- Nutrient deficiencies (vitamin D, folate, zinc, iron, calcium, etc.)
- Anemia (iron deficiency anemia, etc.)

Sex hormone abnormalities:

- Menstrual irregularities (hypothalamic amenorrhea, oligomenorrhea)

Bone metabolism abnormalities:

- Low BMD (osteoporosis or osteopenia)

Other metabolic abnormalities:

- Impaired glucose tolerance
- Low T3 syndrome
- Dyslipidemia

Circulatory and hematological abnormalities:

- Bradycardia
- Hypotension

Psychological, neurological, and systemic symptoms:

- Psychological symptoms (depression, anxiety, decreased concentration, cognitive impairment)
- Physical symptoms (general fatigue, sleep disorders, cold sensitivity, headaches, constipation, deterioration of hair and skin quality)

- Decreased physical activity

FUS is defined as "a condition in which diseases, symptoms, and signs are present as complications against a background of underweight or undernutrition as the causative factor." This working group attempted to clarify the overall picture of health disorders caused by underweight and undernutrition and establish diagnostic criteria. However, due to insufficient evidence to clearly define criteria, we currently limit ourselves to presenting the framework as a disease concept.

The essential purpose of establishing the FUS concept is to focus on "diverse health disorders primarily caused by underweight and undernutrition that cannot be explained by other obvious diseases" and to construct frameworks for early detection, prevention, and intervention. Furthermore, since patients with underlying diseases require prioritized appropriate treatment, eating disorders and secondary underweight (hyperthyroidism, malignant diseases, etc.) should not be considered as FUS, and treatment of the primary disease should be prioritized.

The current FUS concept is primarily designed for women aged 18 years and above until menopause, and does not include postmenopausal women or men. This is because the hormonal environment and aging factors may become more significant in postmenopausal women, requiring discussion about the causes of diseases, symptoms, and signs. While health disorders associated with underweight and undernutrition may also occur in men, the prevalence and impact are currently more prominent in women; thus, men were not included in this concept. However, if evidence accumulates regarding pathology and health disorders in these populations in the future, expansion of FUS applicability or redefinition of the disease concept may be considered.

3.3 | Attention to and Countermeasures Against Stigma

Careful attention must be paid to the potential creation of new stigma through the proposal of this syndrome. For example, there exists a risk of promoting prejudice against constitutionally thin women. Additionally, it is necessary to consider the social factors contributing to increased desires for thinness in Japanese society, as well as cases of undernutrition due to poverty or insufficient food intake due to lack of social support. Therefore, proposing this syndrome requires considering multifaceted support systems rather than viewing undernutrition as merely individual responsibility. Consequently, while proposing this syndrome, it is essential to promote understanding of the fundamental issues including social factors and to ensure consideration that avoids blaming individuals, preventing the intensification of self-blame.

4 | Causes and Management of FUS

4.1 | Causes of FUS

The causes of FUS are multifaceted, arising from complex interactions among individual physical characteristics, social factors, and psychological factors. Here we organize them from three major perspectives.

Constitutional thinness (inherent constitution): Constitutional thinness refers to constitutional characteristics where low body weight persists long-term without desires for thinness, eating disorders, or excessive exercise [25]. Generally, while weight gain is difficult, endocrine function and menstrual cycles are maintained normally. Reports indicate that approximately 40% of thin Japanese women have not engaged in intentional weight loss behaviors including dietary restriction [4], though whether all constitute constitutional thinness remains unclear.

Psychological and social factors: The value of "thinness equals beauty" permeates through people and media including SNS, and women who internalize this are prone to developing body dissatisfaction and excessive desires for thinness. Such psychological tendencies become factors that strengthen weight loss behaviors centered on dietary restriction. When excessive dietary restriction or imbalanced eating habits become prolonged, individuals fall into underweight and undernutrition states, becoming susceptible to various health disorders including decreased BMD and menstrual irregularities.

Socioeconomic Factors and Undernutrition Due to Poverty: Cases have been reported where poverty prevents adequate food access, resulting in low BMI and undernutrition [26]. In such cases, resolution through individual effort alone is difficult, requiring structural social support and political measures.

These factors overlap and interact, potentially leading to underweight, specific nutrient deficiencies, decreased BMD, menstrual irregularities, poor physical condition, and ultimately FUS.

4.2 | Management of FUS

Managing FUS requires both "individualized approaches according to causes" and "comprehensive interventions at social and educational levels."

4.2.1 | Response to Constitutional Thinness

Even in constitutional thinness, decreased BMD risk has been identified [27], making BMD measurements, blood tests, and nutritional guidance as needed important during health examinations. Adequate intake of vitamin D and calcium, along with total energy intake, is recommended.

4.2.2 | Response to Those With Desires for Thinness

Since excessive desires for thinness widely prevalent among young women carry various health risks, educational interventions to promote correct understanding are necessary. Specifically, the following items should be emphasized in body image education and health literacy education within school settings:

- Formation of appropriate body image and understanding of body type diversity.
- Development of abilities to appropriately evaluate and utilize media information.

- Promoting understanding of health risks caused by excessive thinness behaviors.
- Understanding the importance of balanced nutrition and health problems caused by meal skipping.

However, many adults including the current parent generation perceive ideal weight as biased toward thin body types, and negative comments about children's body types may promote desires for thinness. Therefore, broad awareness activities, including adults surrounding children, are required to promote understanding of this health issue, body type diversity, and inclusive values. Promoting awareness activities regarding this issue and inclusive attitudes toward body types through collaboration with companies and organizations is also important.

For health risks such as menstrual irregularities and decreased BMD, establishing systems for early diagnosis and intervention through screening at health examinations and collaboration among specialists including nutritionists, physicians, and psychological counselors is desirable. Additionally, attention should be paid to the fact that energy restriction is known to cause decreased physical activity [23], which may secondarily create physical symptoms characteristic of FUS. Indeed, reports indicate that underweight young Japanese women have both lower energy intake and physical activity compared to those of standard weight, with many following a pattern of "not eating and not moving" [13].

4.2.3 | Response to Social and Economic Factors

When adequate meals cannot be secured for economic reasons, health disparities expand, increasing risks of undernutrition and underweight. In response, expanding support from local governments and social welfare organizations and increasing venues providing nutritionally balanced meals such as food banks and Kodomo Shokudo (children's cafeterias) is required [28]. The problem of undernutrition due to poverty extends beyond adult women aged 18 and above targeted by FUS to children under 18 in their growth period, potentially causing more serious impacts. Presenting the FUS disease concept does not diminish the importance of related issues arising from these social factors but should rather serve as an opportunity to discuss them in parallel as health issues with common backgrounds and promote comprehensive social responses.

5 | Future Directions and Recommendations

5.1 | Guideline Development

Unified screening items including physical symptoms, bone mass measurements, menstruation, and nutritional assessment need to be established with clear diagnostic criteria. This requires research that can provide evidence for FUS.

5.2 | Integration Into Health Screening Systems

There may be a need to establish mechanisms for including FUS screening in specific health guidance and workplace health examinations, with additional measurements and interventions. While various health examinations implement interventions targeting obesity, a similar priority needs to be given to underweight/undernutrition and related diseases. Early detection and intervention for decreased bone mass is particularly important from the perspective of maintaining women's health throughout their life course.

5.3 | Collaboration With Education and Industry

Expansion of opportunities to learn correct dietary habits and acquire appropriate body image through health education in elementary, middle, and high schools, as well as health awareness programs for university students, is required. Strengthening psychological support systems is equally important. For fashion and beauty industries, encouraging review of advertising expressions that excessively promote thinness and developing guidelines that affirm diverse body types is desirable. Furthermore, awareness activities in collaboration with related organizations are needed to prevent the proliferation of incorrect diet information in the media.

5.4 | Comprehensive Approach Through Collaboration With the Strategic Innovation Promotion Program (SIP)

Solving health issues associated with underweight and undernutrition requires multifaceted approaches linking medical, educational, and industrial sectors. The third phase of the Cabinet Office's Strategic Innovation Promotion Program (SIP) also aims to "improve women's body image and health," advancing nationwide research, educational tool development, and promotion of inclusive body image through social movements. Additionally, a council comprising companies and organizations (My Well Body Council) has been established to promote awareness activities. Academic societies can accelerate implementation by utilizing evidence from SIP for guideline development and public relations activities while strengthening collaboration with companies and government.

6 | Conclusion

In Japan, health disorders caused by underweight and undernutrition in premenopausal adult women represent important issues affecting not only individual health but society as a whole. The FUS proposed in this paper is expected to comprehensively organize these issues and serve as a foundation for promoting systematic diagnosis and intervention.

Meanwhile, to prevent the emergence of new stigma, fostering inclusive social consciousness that respects body type diversity is required. Additionally, establishing multifaceted support systems including social, psychological, and economic factors is essential, rather than viewing underweight and undernutrition problems as individual responsibility.

Future efforts should enhance diagnostic criteria and prevention/intervention programs, promoting comprehensive approaches uniting medical, educational, governmental, and

industrial sectors. These initiatives are expected to contribute to improving the health of young Japanese women and promoting the health of future generations.

Author Contributions

Y.T. drafted the manuscript. All authors contributed to the development of the statement through Working Group discussions, critically reviewed the manuscript, and approved the final version.

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Disclosure

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Conflicts of Interest

Wataru Ogawa received honoraria for lectures from Sumitomo Pharma, Nordisk Pharma, and Eli Lilly Japan, and research grants from Novo Nordisk Pharma and Nippon Boehringer Ingelheim. Yasushi Ishigaki received honoraria for lectures from Novo Nordisk, Eli Lilly Japan, Sumitomo Pharma, and Kowa, and research grants from Novo Nordisk and Sanofi. Yushi Hirota received honoraria for lectures from Dexcom Japan and research grants from Medtronic Japan. Sakae Tanaka received honoraria for lectures from Amgen and Daiichi Sankyo, and research grants from Nipro and Rohto Pharmaceutical. Masakazu Terauchi received honoraria for lectures from Hisamitsu Pharmaceutical and Fuji Pharma, and unrestricted research grants from Ibaraki Prefecture and Japan Agricultural Cooperatives of Ibaraki Prefecture. All other authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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