Review
CLINICAL TRIALS AND INVESTIGATIONS

Obesity

Proposal for a Scientifically Correct and Medically Actionable Disease Classification System (ICD) for Obesity

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Objective: Obesity is responsible for a huge burden of suffering and social costs, and yet many patients lack access to evidence-based therapies. The diagnostic term "obesity" and inadequate *International Classification of Diseases* (ICD) codes contribute to suboptimal efforts to prevent and treat obesity as a chronic disease. The goal of this review is to develop a medically actionable classification system based on the diagnostic term "adiposity-based chronic disease" (ABCD) that reflects disease pathophysiology and specific complications causing morbidity and mortality.

Methods: A coding system based on the diagnosis of ABCD with four domains is proposed: A codes reflect pathophysiology, B codes indicate BMI classification, C codes specify specific biomechanical and cardiovascular complications remediable by weight loss, and D codes indicate the degree of the severity of complications. Supplemental codes identify aggravating factors that complicate care and that are relevant to a personalized therapeutic plan.

Results: The coding system addresses pathophysiology and therapeutic goals and differential risk, presence, and severity of specific complications that are integral to ABCD as a chronic disease.

Conclusions: The scientifically correct and medically actionable approach to diagnosis and disease coding will lead to greater acknowledgement of ABCD as a disease and accessibility to evidence-based therapies on behalf of patients across the life cycle.

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Study Importance

What is already known?

- The diagnosis of obesity is currently based only on BMI, without an indication of the impact of excess adiposity on health.
- The current key ICD code for obesity reads "obesity due to excess calories," which is not medically meaningful and does not reflect obesity pathogenesis.
- These inadequacies contribute to a lack of access for patients to evidence-based therapies and a lack of appreciation of obesity as a chronic disease.

What does this review add?

- This review proposes a scientifically correct and medically actionable disease classification system for obesity.
- Disease classification is structured around the diagnostic term "adiposity-based chronic disease," which reflects both the pathophysiology and clinical impact as a chronic disease.
- The proposed coding system has four domains (pathophysiology, BMI classification, complications, and complication severity) and incorporates disease staging, specific complications that impact health, the basis for clinical intervention, individualized treatment goals, and a personalized medicine approach.

Introduction: Obesity as a Disease–Rationale and Mechanisms

Obesity was designated as a disease by the American Association of Clinical Endocrinologists (AACE) in 2012 (1), by the American Medical Association in 2013 (2), and subsequently by multiple medical professional and national associations (3). The rationale is that obesity meets essential criteria of a disease (4), including overt signs and symptoms (i.e., BMI), underlying pathological dysfunction (e.g., dysregulated satiety hormone control of caloric intake) (5), and having complications that confer morbidity and mortality (6,7). Two broad categories of obesity complications are biomechanical complications, which arise from a generalized increase in adipose tissue mass, producing impairment in mechanical functions, and cardiometabolic complications, which arise because of abnormalities in the distribution and function of adipose tissue that give rise to a

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TABLE 1 Complications of obesity and response to weight loss

Biomechanical (7)	Responds to weight loss	Cardiometabolic (7)	Responds to weight loss
Obstructive sleep apnea	✓	Prediabetes/metabolic syndrome	✓
Obesity hypoventilation syndrome	✓	Type 2 diabetes	✓
Asthma/reactive airways disease	✓	Dyslipidemia	✓
Osteoarthritis (knee, hip)	✓	Hypertension	✓
Urinary stress incontinence	✓	Nonalcoholic fatty liver disease	✓
Gastroesophageal reflux disease	✓	Polycystic ovary syndrome	✓
Immobility/disability	✓	Female infertility	✓
		Male hypogonadism	✓

Aggravating factors: social and environmental determinants of health as well as psychological comorbidities (including stigmatization, depression, anxiety disorder, and binge-eating syndrome) can complicate care in individual patients and are relevant to developing a personalized therapeutic plan.
✓ = grade A or B evidence that the complication arises because of obesity and can be ameliorated by weight loss therapy. Note that weight loss associated with bariatric surgery has been shown to reduce CVD events and decrease mortality (7).

pathophysiological process (8-14), producing both end-stage metabolic and vascular sequelae. The progression of cardiometabolic complications begins with insulin resistance, progresses to the high-risk states of metabolic syndrome (MetS) and prediabetes, and then culminates in type 2 diabetes (T2D), nonalcoholic fatty liver disease (NAFLD), cardiovascular disease (CVD), or all three in single individuals. The insulin-resistant state is central to the pathophysiology of cardiometabolic disease via the following: (1) defects in glucose homeostasis, substrate oxidation, and mitochondrial function; (2) increased inflammation and oxidative stress; (3) alterations in lipids and lipoproteins contributing to CVD risk; (4) impaired lipid storage in adipocytes associated with the accumulation of ectopic lipids in muscle cells and hepatocytes; and (5) increased vasoreactivity due to a reduction in endothelial nitric oxide synthase activity and nitric oxide production (9-21). Obesity exacerbates insulin resistance and can impel cardiometabolic disease progression toward T2D, NAFLD, and CVD (9,10,22,23). Thus, beyond simple increases in adipose tissue mass, abnormalities in adipose tissue function and distribution are critically involved in the pathogenesis of cardiometabolic complications in obesity (8).

Most, but not all, complications can be prevented or treated by weight loss, as delineated in Table 1. Thus, the goal of treatment of obesity as a disease is to improve the health of patients by preventing, ameliorating, or reversing obesity-related complications (6,7). AACE clinical practice guidelines for obesity (7) base clinical decisions on two diagnostic components: the anthropometric component, reflecting adipose mass and distribution, and a clinical component that involves the presence and severity of complications (Supporting Information Table S1). The presence of complications warrants more aggressive interventions that achieve sufficient weight loss to prevent further disease deterioration. Hence, the goal of therapy in treating obesity as a disease is to improve health by preventing or treating complications, as opposed to a primary and simple focus on losing any stipulated amount of weight.

Scope of the Problem

Obesity is responsible for a huge burden of patient suffering and social costs worldwide. To use the United States as an example, Hugh Waters and Marlon Graf of the Milken Institute calculated the direct and indirect costs of obesity as a function of the relative risk that obesity brings to major chronic diseases (24). The total cost attributable to obesity was $1.72 trillion in 2016 ($480.7 billion in direct costs and $1.24 trillion in indirect costs), equivalent to 9.3% of the gross domestic product and accounting for 47% of the total cost of chronic diseases. Nations are paying for the high social costs of obesity in contrast to the relatively low investment in combating the disease (25). The impediments that prevent access of patients to evidence-based therapies have been well documented, and they include the bias that obesity is a lifestyle choice, lack of training in obesity care among health care professionals, stigmatization of patients and self-blaming, insufficient attention to diagnosis, undervaluation of obesity care, and lack of insurance coverage (26-28).

Moreover, there are two additional factors that impede obesity care; these are the diagnostic term "obesity" per se (29) and the medically inadequate ICD coding system. We assert that the imprecise and inaccurate terms used for diagnosis and coding confuse health care policy and contribute to lack of reimbursement and clinical intervention. A transformation in obesity care is warranted, and we endorse a diagnostic approach that can facilitate this transformation: a diagnostic term that indicates what we are treating and why we are treating it, together with a scientifically and medically actionable ICD coding system that reflects the disease's pathophysiological heterogeneity.

A New Diagnostic Term

The diagnosis of obesity is applied to adults with BMI ≥ 30 kg/m^2, and the diagnosis of overweight is applied to adults with BMI of 25 to 29.9 kg/m^2, whereas epidemiological data (30,31) justify BMI ≥ 23 kg/m^2 as the definition of obesity in many Southeast Asian populations (Supporting Information Table S1). In children, obesity is defined as ≥ 95th percentile of BMI (overweight as ≥ 85th percentile) as a function of age and sex by using Centers for Disease Control and Prevention growth charts (32). The lay public and many health care professionals are confused about the significance of obesity based on an anthropometric measurement that interrelates height and weight. BMI is not a direct measure of adiposity and it provides no reference to the health or well-being of individuals. The diagnostic term of obesity conveys no information about complications associated with

excess adiposity that adversely affect health. As a consequence, stakeholders vested in the social consequences of obesity find it difficult to embrace obesity as a term for concerted action (29,33).

Furthermore, the term obesity carries with it extensive stigma in the public domain that has negative implications pertaining to the personal character of patients, generating guilt, depression, and shame (34,35). The bias and uncertainty regarding health implications help perpetuate factors that limit access of patients to effective therapy. A new diagnostic nomenclature is warranted that conceptualizes obesity as a chronic disease associated with complications, alludes to a precise pathophysiological basis, and avoids the stigma, ambiguity, differential use, and multiple meanings of the term obesity.

The AACE has proposed a new diagnostic term, "adiposity-based chronic disease" (ABCD) (8), which has also been recently embraced by the European Association for the Study of Obesity (EASO) (36). The phrase "adiposity-based" is justified because the disease is primarily due to abnormalities in the mass, distribution, and/or function of adipose tissue. Strictly speaking, abnormalities in adipose function and mass could include diseases such as lipodystrophy and anorexia nervosa; however, the proposed use of the ABCD diagnostic term is limited to patients with an increased BMI and adipose tissue mass in whom health can be improved with weight loss therapy. The phrase "chronic disease" indicates that the disease is lifelong and associated with complications that confer morbidity and mortality, and that it has a natural history that offers opportunities for primary, secondary, and tertiary prevention (7). The new diagnostic term provides a conceptual basis that can help inform and structure the evaluation and diagnosis of patients with obesity.

Current ICD-10 Obesity Coding is Inadequate

The current *International Classification of Diseases, Tenth Revision* (ICD-10) code for obesity lies within the block of "endocrine, nutritional and metabolic diseases" (E00-E99) (37) (specific codes shown in Box 1). The key code, E66.0, which describes "obesity due to excess calories," does not indicate the cause of excess calories and could be translated as "you're fat because you eat too much." The shortcomings of ICD-10 coding for obesity have previously been delineated by Hebebrand et al. and the EASO (38). Briefly, there is no accurate methodology in clinical practice for quantifying caloric ingestion, and the descriptor ignores the energy expenditure component of energy balance. The remaining subcategories are incomplete and confusing, with nonspecific references to "other obesity" and "obesity, unspecified." The descriptors are woefully inadequate from scientific and medical perspectives for a disease with a biological basis and responsible for a massive burden of suffering and social cost. The coding does not reflect current knowledge regarding pathophysiological processes that generate and sustain excess adiposity and does not indicate the impact of excess adiposity on health. The code descriptors are not explicitly clear that obesity is a disease rather than a lifestyle choice to consume excess calories, and they have the potential to contribute to the lack of access to evidence-based therapies for patients with obesity. The current obesity codes need to be expunged and replaced with a scientifically correct and medically meaningful ICD coding system that facilitates appropriate reimbursements for comprehensive obesity prevention and management.

Box 1 ICD-10 Coding for Obesity

E66. Obesity
- E66.0 Obesity due to excess calories
- E66.1 Drug-induced obesity
- E66.2 Extreme obesity with alveolar hypoventilation
- E66.8 Other obesity
- E66.9 Obesity, unspecified

What has been done to correct this problem? The World Health Organization *International Classification of Diseases, Eleventh Revision* (ICD-11) codes have been finalized (but not yet implemented) and do improve on obesity coding (39,40). The coding recognizes overweight and obesity occurring in adults and children, with separate codes for BMI categories. The scheme recognizes genetic forms of obesity and maintains the category of drug-induced obesity. However, the proposed draft lists obesity under nutritional disorders, which continues to ignore the complex pathogenesis of obesity. Interdigitated with these codes is an entry for "overweight or localized adiposity," which lacks clear relevance to the highly prevalent condition of overweight per se. Significantly, the draft for the ICD-11 does not recognize the health implications of overweight or obesity with reference to disease complications.

The EASO has proposed an improved coding system that addresses the pathophysiological heterogeneity of obesity (38). The authors base their coding on three dimensions. The first dimension is etiology, which includes two mechanistic categories: (1) multifactorial disease, representing the majority of patients, and (2) obesity arising from specific identifiable factors such as genetic abnormalities, endocrine disorders, iatrogenic causes, immobilization, or psychiatric disease. The second dimension is the degree of adiposity, encompassing six categories of BMI values. The third dimension is health risk graded from low, to intermediate, to high. Low risk encompasses obesity without complications. Intermediate risk incorporates a broad array of factors, including family history of cardiometabolic disease, cigarette smoking, physical inactivity, and the presence of MetS traits. High risk is defined as the presence of T2D, MetS, CVD, chronic kidney disease, and musculoskeletal disorders. The groundbreaking EASO proposal constitutes a noteworthy advance in that it recognizes obesity as a heterogeneous disease with respect to pathophysiology and incorporates a dimension that reflects the impact of excess adiposity on health. The proposal also calls for assessment of waist circumference as an indicator of ventral adipose tissue mass, recognizing that abnormalities in both adipose tissue mass and distribution can contribute to the burden of complications. However, separate codes are not provided that link obesity to specific single complications that can be prevented or treated by weight loss in individual patients, and complications can vary from mild-moderate to severe even within the EASO categories of intermediate or severe health risks.

Proposed Structure for a New ICD Coding System

We propose a coding strategy that discriminates among pathophysiological aspects of obesity because this has important ramifications regarding complications, therapy, and treatment goals. In contrast to the current ICD-10 system, the proposed paradigm reflects our current scientific understanding of the disease and denotes clinical heterogeneity. Our proposal is built on the foundational work of the EASO (38). Importantly,

however, the current coding system is structured around the diagnostic term ABCD, which is well suited to accurately reflect differences in the disease's natural history as a function of abnormalities in adipose tissue mass, distribution, and function. The use of the diagnostic term better defines "what is being treated." Another important feature is that separate codes are provided to specify single complications, particularly those that can be ameliorated through weight loss and comprehensive care of patients with obesity. The reference to specific complications indicates "why we are treating" by linking obesity care to therapeutic objectives. The coding designates ABCD with and without identifiable causal factors, such as monogenetic and syndromic genetic disease, as well as ABCD arising from endocrine diseases, iatrogenic medications, and disability. There are also supplemental codes for aggravating factors (AF) that help drive and sustain weight gain, that complicate care, and that need to be considered for a personalized medicine approach. These combined aspects of pathophysiology impact the clinical course and goals of therapy regarding patient health and predict differential risk, presence, and severity of specific complications that are integral to ABCD as a chronic disease. In aggregate, the coding scheme designates and facilitates a personalized approach to obesity care by recognizing disease context in individual patients.

With respect to the ABCD complications in the coding proposal, the AACE obesity guidelines provide extensive scientific evidence that these complications are attributable to obesity and that these complications can effectively be prevented or treated by weight loss therapy (7). The current coding system reflects the evidence base of these guidelines regarding complications treatable by weight loss. In this way, the proposed system advances the approach to obesity management beyond the simple loss of body weight as a primary endeavor to a plan that focuses on improving patient health. The proposed codes emphasize and promote a comprehensive approach to patient management, with attention directed to the risk profile and presence of complications in individual patients. Complications-directed therapy entails a holistic approach to patient health that optimally would involve a multidisciplinary team for addressing behavior, fitness, sleep hygiene, psychological overlay, and quality of life, in addition to behavioral, medical, and surgical interventions for weight loss, all directed at prevention and treatment of chronic complications of the disease. Thus, the new proposed ICD coding system is medically actionable. By recognizing the complication profile in individual patients, the ICD coding reflects what we are treating, why we are treating it, and the therapeutic goals that define the success of intervention. In this way, the coding system entrains good clinical practice and provides a framework for reimbursement for care of ABCD as a chronic disease.

Frühbeck et al. (41) have advocated that coding systems should promote a personalized approach for diagnosis and treatment that recognizes the syndemic nature of obesity and its complications. Personalized intervention requires an appreciation of the genetic and biological basis of obesity together with the impact of behavioral, cultural, socioeconomic, and environmental factors. The syndemic nature of obesity involves three core elements: (1) clustering of obesity and its complications (e.g., obesity, T2D, hypertension, sleep apnea); (2) biological, psychological, and socioeconomic interactions; and (3) social forces that promote disease clustering (41). The proposed coding system incorporates these principles and, thus, helps support a personalized approach to obesity medicine. Specific examples include the following: (1) coding that recognizes links between obesity and specific complications in individual patients, (2) the intent of weight loss therapy to address syndemic aspects of obesity, (3) the importance of psychological comorbidities as an aggravating cause, and (4) overriding behavioral, cultural, and environmental factors that are important regarding both obesity pathogenesis and the design of individualized treatment programs. These latter factors encompass the social determinants of health that are important to consider because they variably impact the disease among patients. Coding that addresses the role of these factors is intended to promote a personalized medicine approach and effective individualized treatment programs for enhanced care.

The ICD coding system is delineated in Table 2 and illustrated in Figure 1. There are four domains of coding.

ABCD pathophysiology is designated by A codes that identify both primary ABCD without overt causal influence and secondary ABCD arising from or aggravated by identifiable causes. There are two categories of secondary ABCD: genetic and "other," which includes endocrine disease, iatrogenic medications, and immobilization or disability. ABCD without overt causal influence (A.1) is highly polygenic, with multiple susceptibility genes each conferring a small relative risk for the disease. ABCD due to genetic mutations (A.2) involves a single gene or chromosomal region and occurs in a smaller number of patients. This can result in nonsyndromic or monogenic ABCD or syndromic ABCD in which excess adiposity occurs concomitant with an array of developmental and neurocognitive abnormalities. ABCD due to other causes (A.3) can arise as a consequence of endocrine disorders, iatrogenic dispensation of medications that promote weight gain, long-term immobilization, or disability (e.g., spinal cord injury).

In individual patients, regardless of the pathophysiological A code, ABCD can be substantially aggravated by comorbidities and factors that help drive and sustain weight gain, that complicate care, and that are relevant to the development of personalized therapeutic plans. These factors are recognized by supplemental codes for AF, including codes for psychological comorbidities diagnosed by using *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* criteria, such as depression, anxiety disorder, and binge-eating syndrome. Here we differentiate between comorbidity and complication. Complication designates a harmful consequence of obesity as a chronic disease for which obesity features prominently in its development, particularly when treatable by weight loss. Comorbidities are not caused by or do not arise primarily as a function of obesity but they can be associated with and can aggravate obesity and vice versa. It is important to incorporate psychological comorbidities into the diagnostic scheme because they complicate care and they often need to be addressed in developing effective treatment plans in individual patients. The same applies to behavioral, cultural, or environmental factors and social determinants of health (including stigma and stress) when these factors play a prominent role in driving and sustaining weight gain. In many patients, it is critical that these factors be addressed in the treatment plan for enhanced outcomes, consistent with a personalized medicine approach in obesity care.

BMI classification is designated by B codes. The codes can be adapted and applied to ethnicities more severely affected by ABCD at lower BMI levels as well to children and adolescents by using BMI percentiles based on age and sex (Supporting Information Table S1).

ABCD-related complications are indicated by C codes. C.0 identifies patients without complications. In these patients, secondary prevention

TABLE 2 Proposed clinically relevant ICD coding system for ABCD

Domain A: ABCD pathophysiological category

ABCD 1 Primary ABCD without overt causal influence

A.1 ABCD without identifiable causes or AF

ABCD 2 ABCD primarily attributable to identifiable genetic abnormalities

A.2.0 Genetic abnormality, unspecified

Monogenetic abnormality

A.2.1 Leptin
A.2.2 Leptin receptor
A.2.3 Prohormone convertase 1 deficiency
A.2.4 Proopiomelanocortin deficiency
A.2.5 Melanocortin 4 receptor deficiency
A.2.6 SIM1 deficiency

Syndromic obesity

A.2.7 Prader-Willi syndrome
A.2.8 Alström syndrome
A.2.9 Beckwith-Wiedemann syndrome
A.2.10 Bardet-Biedl syndrome
A.2.11 WAGR-O syndrome (*BDNF*)
A.2.12 Wilson-Turner syndrome
A.2.13 MEHMO syndrome
A.2.14 Pseudohypoparathyroidism
A.2.15 ROHHAD syndrome

ABCD 3 ABCD arising from or aggravated by other causes: endocrine diseases, iatrogenic medications, disability

A.3.1.0 Associated with endocrine disorder, unspecified
A.3.1.1 Hypothyroidism
A.3.1.2 Hypercortisolism
A.3.1.3 Hypopituitarism
A.3.1.4 Hypothalamic/CNS injury
A.3.2 Arising from or aggravated by medications (iatrogenic)
A.3.3 Arising from or aggravated by immobilization or disability

AF Supplemental A codes to indicate AF that complicate care and are relevant to a personalized therapeutic plan

AF.1 Social and environmental determinants of health

AF.1.1 Arising predominantly because of behaviors or cultural factors that promote positive energy balance

AF1.2 Arising because of overriding environmental factors or social determinants that promote positive energy balance (e.g., built environment, work related, physical activity resources, time management, stress, stigma)

AF.2 Associated with psychological comorbidity

AF.2.1 Anxiety disorder
AF.2.2 Depression
AF.2.3 Binge-eating syndrome
AF.2.4 Night-eating syndrome
AF.2.5 Psychoses

AF.3 Other comorbid disease that complicates care for ABCD

Domain B: BMI classification[a]

B.0 Normal weight (BMI 18.5-24.9; 18.5-22.9 in Southeast Asian individuals; < 85th percentile for age in children and adolescents)

B.1 Overweight (BMI 25-29.9; 23-24.9 in Southeast Asian individuals; 85th-94.9th percentile for age in children and adolescents)

TABLE 2 (continued).

B.2 Obesity (BMI ≥ 30; ≥ 25 in Southeast Asian individuals; ≥ 95th percentile for age in children and adolescents)

B.2.1 Obesity class I (BMI 30-34.9)
B.2.2 Obesity class II (BMI 35-39.9)
B.2.3 Obesity class III (BMI ≥ 40)

Domain C: Obesity-related complications[b]

ABCD C.0 ABCD without complications

ABCD C.1 ABCD with complications due to abnormality in adipose tissue mass

C.1.0 Presence of biomechanical complications, unspecified

C.1.1 Obstructive sleep apnea
C.1.2 Obesity hypoventilation syndrome
C.1.3 Osteoarthritis of the knee or hip
C.1.4 Urinary stress incontinence
C.1.5 Gastroesophageal reflux disease
C.1.6 Immobility/disability
C.1.7 Pseudotumor cerebri
C.1.8 Pain syndromes (e.g., back pain, lower extremity)
C.1.9 Venous insufficiency (e.g., dependent edema, varicose veins)

ABCD C.2 ABCD with complications due to abnormalities in adipose distribution and function

C.2.0 Presence of cardiometabolic complications, unspecified

C.2.1 Prediabetes
C.2.2 MetS
C.2.3 T2D
C.2.4 Hypertension
C.2.5 Dyslipidemia
C.2.6 CVD
C.2.7 NAFLD

ABCD C.3 ABCD with complications involving sex steroids and fertility

C.3.1 PCOS

3.1.1 ABCD with PCOS treated for dysmetabolism
3.1.2 ABCD with PCOS treated for oligomenorrhea
3.1.3 ABCD with PCOS treated for anovulation/infertility

C.3.2 Female infertility

C.3.3 Menstrual irregularities

C.3.4 Male hypogonadism

ABCD C.4 Other complications

C.4.1 Gallbladder disease

Domain D: Degree of severity of ABCD-related complications[c]

ABCD D.1 ABCD with mild to moderate complications

ABCD D.2 ABCD with severe complications

[a]Evidenced-based classification involving direct measures of body fat mass can be substituted for BMI.
[b]Emphasis on ABCD-related complications that can be treated with weight loss within context of comprehensive care of patient with ABCD.
[c]Proposed criteria for disease severity categorizations; actual criteria should be determined by data and by expert opinion over time (see Table 3).
Domain A: Codes beginning with "A" indicate ABCD pathophysiological category; "AF" represents supplemental codes indicating aggravating factors that complicate care. Domain B: codes beginning with "B" indicate BMI classification. Domain C: codes beginning with "C" indicate complications from ABCD. Domain D: codes beginning with "D" indicate degree of severity of complications.
CNS, central nervous system; MEHMO, mental retardation, epileptic seizures, hypogenitalism, microcephaly, obesity; PCOS, polycystic ovary syndrome; ROHHAD, rapid-onset obesity with hypothalamic dysregulation, hypoventilation, and autonomic dysregulation; SIM1, single-minded homolog 1; WAGR-O, Wilms Tumor, aniridia syndrome, genitourinary abnormalities, mental retardation with obesity.

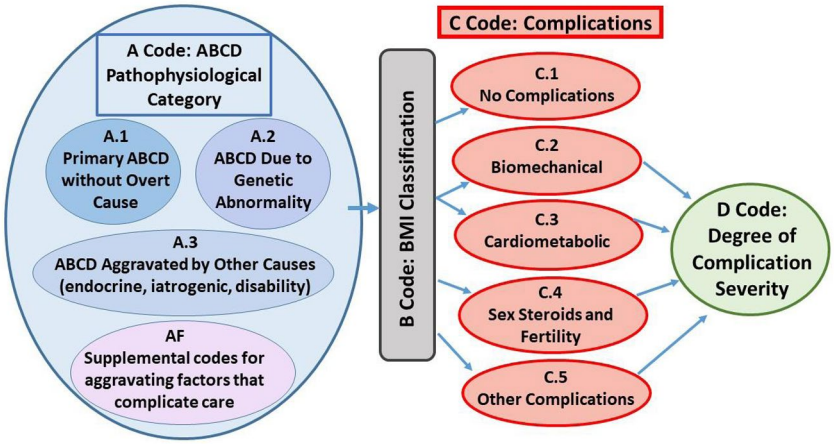

Figure 1 Structure for proposed ICD coding system for ABCD. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Examples of severity coding for selected ABCD complications for illustration: proposed criteria[a]

ABCD complication	ABCD code[b]	Complications severity code[a,c]	Proposed criteria[a,c]	References
Biomechanical complications				
Obstructive sleep apnea	A.1/C.1.1	D.1	AHI 5 to 30 ± clinical assessment	(45)
	…	D.2	AHI > 30 ± clinical assessment	…
Osteoarthritis (knee, hip)	A.1/C.1.3	D.1	WOMAC score 1-5 ± clinical assessment	(46)
	…	D.2	WOMAC score 5-10 ± clinical assessment	…
Urinary stress incontinence	A.1/C.1.4	D.1	ISI score 6-16 ± clinical assessment	(47)
	…	D.2	ISI score ≥ 17 ± clinical assessment	…
Gastroesophageal reflux disease	A.1/C.1.5	D.1	Symptoms; nonerosive	…
	…	D.2	Erosive, Barrett's esophagus	…
Cardiometabolic complications				
Prediabetes	A.1/C.2.1	D.1	CMDS score 1 or 2	(42)
	…	D.2	CMDS score 3	…
MetS	A.1/C.2.2	D.1	CMDS score 1 or 2	(42)
	…	D.2	CMDS score 3	…
T2D	A.1/C.2.3	D.1	No vascular complication	…
	…	D.2	Micro- or macrovascular complications	…
Hypertension	A.1/C.2.4	D.1	Prehypertension	…
		D.2	Hypertension	…
NAFLD	A.1/C.2.7	D.1	Steatosis only; NAS F1	(48)
	…	D.2	NAS score F2-F4 or NASH by ultrasound elastography, MRI, fibrosis risk score	…

[a]Criteria for disease severity categorizations are proposed and should be actually determined by data and expert opinion.
[b]Selected complications and corresponding C codes from Table 2. Codes A.2 (genetic) or A.3 (other causes) could be substituted for A.1 (no overt causal influence) code.
[c]D codes for severity could apply to any B codes for BMI classification (i.e., B.1 or B.2).
AHI, apnea hypopnea index; CMDS, Cardiometabolic Disease Staging; ISI, incontinence symptom index; MRI, magnetic resonance imaging; NAS, NASH activity histological score; NASH, non-alcoholic steatohepatitis; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

measures are required to prevent further weight gain and the emergence of complications. The development of complications indicates that excess adiposity is sufficient to impair health regardless of BMI classification, sex, or age. At this point in the natural history of the chronic disease, tertiary prevention interventions are needed to treat complications and prevent further deterioration. C codes recognize the role of abnormalities in adipose tissue mass versus distribution and function. Specific biomechanical complications (C.1 codes) arise

because of an increase in adipose tissue mass and include obstructive sleep apnea, obesity hypoventilation syndrome, osteoarthritis of the knee or hip, urinary stress incontinence, gastroesophageal reflux disease, pain syndromes, and immobility/disability. Patients with abnormalities in adipose tissue distribution and function (C.2 codes) are insulin resistant and develop cardiometabolic complications, including prediabetes, MetS, T2D, hypertension, dyslipidemia, NAFLD, and CVD. Additional complications can involve sex steroids causing abnormal gonadal function and infertility in patients with polycystic ovary syndrome, female infertility, and male hypogonadism (C.3 codes). Thus, C codes designate specific single complications that are treatable through weight loss within the context of comprehensive care of the patient with ABCD.

Degree of complication severity is indicated by D codes. Each separate complication is adjudicated to be mild to moderate (D.1) or severe (D.2) by using complication-specific criteria, with direct implications regarding modalities and intensity of therapy. Table 3 provides an illustration of potential criteria designating disease severity for selected complications, but actual criteria should be determined by data and expert opinion relevant to each complication. For example, Cardiometabolic Disease Staging uses readily available quantitative clinical data (i.e., MetS traits) to stratify risk for progression to diabetes and CVD among patients with obesity, and this can be used by clinicians to target aggressive weight loss therapy to prevent diabetes in those at highest risk (42,43). These code designations for disease severity are relevant to professional compensation because they provide the rationale for a given intensity of the intervention and comprehensive care approach. More aggressive obesity therapies targeted to more severe disease would predictably increase the benefit/risk ratio and cost-effectiveness of the intervention (43).

Additional Considerations and Implications

The proposed coding strategy requires several points of clarification. It is clear that patients with ABCD, with or without identifiable causes, may develop multiple chronic complications, and coding for each of the multiple biomechanical and/or cardiometabolic complications (C codes) would be warranted to the extent that they are under active management and treatment. Supporting Information Figure S1 provides a coding illustration for a patient with multiple complications. It is also clear that many ABCD complications could occur in lean individuals or arise in ways that are not related to ABCD (e.g., osteoarthritis due to overuse; infertility due to congenital abnormalities). In these instances, coding for these entities would not involve ABCD codes; rather, care would be covered under alternative codes specifically relevant to these illnesses. The ABCD codes would be reserved for complications related to ABCD and when the primary approach to therapy involves weight loss in the context of comprehensive care of the patient with ABCD.

The impact of BMI on health, as well as body composition and fat distribution at any BMI level, can vary as a function of age, sex, and race/ethnicity. However, the complication-centric approach to coding is based on the presence and severity of specific weight-related complications and, from that perspective, is independent of these variables and the degree of BMI elevation (6,7). It is still important to emphasize that the impact on health regarding any ABCD classification is determined by factors variably operative in individuals (see AF codes for AF and social determinants of health in Table 2). Furthermore, therapeutic modality and intensity will need to be individualized based on these same variables. For example, in elderly patients, clinicians should assess the presence of osteopenia and sarcopenia and modify therapy accordingly because these processes can worsen with weight loss therapy. This particularly applies to children and adolescents, in whom ABCD can have more devastating consequences over the lifetime of these patients. The diagnostic and classification scheme will require more scrutiny for optimal application in both children/adolescents and the elderly; these are patient subgroups for whom more data are required regarding the natural history of ABCD, the relationship between BMI and outcomes, and the benefit/risk for ABCD therapies.

Our coding system addresses only those complications that can be prevented or ameliorated by using weight loss therapy based on current data (7). For example, although certain cancers can be appropriately be envisioned as complications of obesity, we do not feel there is sufficient high-quality data to indicate that weight loss can prevent or treat cancer. Another example of such an obesity complication is gallbladder disease, which can in fact be exacerbated by weight loss. Our system is medically actionable; codes provide for weight loss interventions that improve the health of the patient by preventing or ameliorating complications for which data can provide justification. Health care systems and medical coverage ideally support only care that is evidence based, and one of our intentions is that coding systems as billing platforms justify the medical care of patients. The application of weight loss therapy, as structured within the coding system, does not preclude medical treatments specifically targeted to complications when needed, such as medical treatment of hypertension, diabetes, etc.

Codes corresponding to individual complications treatable by weight loss are conducive to a comprehensive therapeutic approach required for treatment of ABCD as a disease. Both the AACE and the EASO have extolled the value of the ABCD diagnostic term and have proposed that this concept be applied to future ICD coding strategies (8,36). This comports exactly with the current proposal. The application of this pathophysiologically relevant and clinically actionable diagnostic and classification system would encourage coverage as needed for comprehensive ABCD care, consultation, and follow-up by physicians and advanced practice professionals employing evidence-based structured lifestyle interventions, obesity medications, and bariatric surgery. In addition, the coding system emphasizes aggressive case finding for ABCD-related complications, clinical evaluation of these complications to assess severity, and consultative referral when needed. The multidisciplinary team would encompass dietitian counseling, exercise therapy, behavioral medicine, psychological and/or psychiatric care, occupational therapy, and physical therapy. In the United States as of 2019, a clear minority of marketplace health insurance plans offer substantial coverage for obesity care, and Medicare policy specifically excludes coverage for obesity medications (44). The European Union has not approved all obesity medications despite the existence of data attesting to safety and efficacy. In short, for many patients internationally, there is a lack of access to evidence-based therapies for ABCD. The proposed use of ABCD for diagnosis and a medically actionable coding system that reflects pathophysiological and clinical heterogeneity will help ensure better access to care for patients with this disease.

Conclusion

We have proposed a system for ICD coding structured on ABCD as a diagnostic term for obesity, which is consistent with the scientific basis of the disease, recognizes pathophysiological heterogeneity, and reflects natural history regarding emergence of specific complications that confer morbidity and mortality. The proposed coding system has the four domains of pathophysiology, BMI classification, complications, and complication severity. Supplemental codes identify AF, such as psychological issues and social determinants, that complicate care and are relevant to a personalized therapeutic plan. The codes encompass disease staging with relevance to the impact of the disease on patients' health, support the basis for clinical intervention, and personalize the goals of therapy. It is hoped that a more scientifically correct and medically actionable approach to diagnosis and disease coding will lead to greater acknowledgement of ABCD as a disease and to greater accessibility to evidence-based therapies on behalf of patients across the life cycle. O

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Supporting information: Additional Supporting Information may be found in the online version of this article.

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