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Prevalence and patterns of pre-competition weight loss practices in Chinese Amateur boxers

Abstract

This study investigated the weight loss (WL) practices of Chinese amateur boxers using the Rapid Weight Loss Questionnaire (RWLQ). A total of 701 (563 males, 138 females) boxers participated in the study and were categorized by sex, age group, and competitive level. Sixty-seven percent of boxers purposefully engaged in WL practices before competition. The average habitual WL was 6.0% (5.8% for juniors and 6.3% for seniors) of body mass (BM), with the average highest WL was 9.5 % (9.1% for juniors and 10.1% for seniors) of BM. Most participants (69% for juniors and 84% for seniors) allocated 15+ days for WL before competition. No significant differences in habitual WL%, highest WL%, and rapid weight loss score (RWLS) were found between age groups or competitive levels (all $p>0.05$). However, males' highest WL% and RWLS were significantly higher than females ($p<0.001$, $p=0.002$, respectively). International boxers began WL later than local boxers (15.5 vs. 14.3 years, $p=0.012$). National boxers began WL later than provincial and local boxers (15.6 vs. 14.8 years, $p<0.001$; 15.6 vs. 14.3 years, $p<0.001$). Increased exercise and training in plastic suits were the most frequently used WL methods. Coaches were identified as the most influential person concerning boxer's WL practices, surpassing doctors or nutritionists. This study found that some WL practices among Chinese boxers differ from those in other sports and countries. Although the prevalence of WL among junior boxers was relatively low, the magnitude of WL was high, warranting more attention in both academic and practical fields.

Keywords: weight cutting, weight cycling, nutrition, behavior, habit, strategy

Introduction

Boxing is one of the most popular combat sports (CS) worldwide, with ~8.6 million boxing participants in the United States of America (USA)[1] and ~600,000 in the United Kingdom (UK).[2] Depending on the organization, boxing is divided into professional boxing and amateur boxing. Amateur boxers compete under categorized body mass (BM) divisions (colloquially known as weight classes) that are intended to promote fair competition and safety. Accordingly, Amateur boxers seek weight classes that provide them the best opportunity to gain a competitive edge over their opponents.[3]

A widely used strategy of CS athletes is to compete in a lower weight class, to perceivably compete against athletes of smaller proportion therefore increasing their competitive advantage.[4-8] One study showed that boxers significantly reduced their nutritional and fluid intake the week preceding the pre competition weigh-in, reducing BM ~5.6% in a process called weight loss (WL).[9] This is followed by rapid weight gain (WG) prior to the competition (approximately 4-14 hours, depending on the time of competition), where targeted refueling and rehydration is used in an attempt to regain as much BM and physiological function as possible. Despite accumulating evidence that WL/WG has adverse effects on athletes' physical, mental, and neuromuscular performance,[9-14] results examining the effects of pre-competition WL practices on success in amateur boxing competition are mixed. Many authors have found no influence of WL/WG on the outcome of boxing competitions.[15, 16] This effect is more pronounced in grappling based CS such as judo and wrestling, where WL has been found to have a more consistent relationship to competitive success.[17, 18] Regardless of the apparent inconsistent effect of WL on performance, there is a strong belief amongst CS athletes that it is

required for competition, which drives the adoption of WL strategies.[8]

As a widespread phenomenon, WL has led to several fatalities[19] and raised concerns in both the scientific community and the lay public.[20, 21] Cross-sectional studies have been widely carried out to understand pre-competition WL practices, and the most commonly used tool is the Rapid Weight Loss Questionnaire (RWLQ) developed by Artioli et al.[22] A recently published systematic review on the WL strategies of CS athletes using the RWLQ found that (i) WL is highly prevalent (66 - 100%); (ii) athletes generally lose <5% of their BM in 7-14 days before competition; and (iii) increased exercise and gradually dieting were the most commonly used WL methods.[23] The CS modality and the country the athlete resides in contribute to the differences reported in WL/WG practices between studies.[23] This may be due to differences in competition rules (such as weigh-in time and weight classes) and culture. Concerning culture, previous research has shown that the WL/WG practices of mixed martial arts (MMA), muay Thai, and sambo athletes were more aggressive than those of other CS athletes.[23] For example, differences in WL/WG practices can be observed between MMA athletes in Brazil and Ireland[24, 25] and between different CS athletes in Brazil.[25, 26]

While several studies have explored the WL practices of CS athletes from various countries and modalities,[4-7, 24-51] only two studies have specifically examined boxers, both have recruited limited samples. Considering the notable achievements of Chinese athletes in amateur boxing at the Paris Olympic Games (three gold and two silver medals), and the lack of research on Chinese athletes in this context, it is valuable to investigate the WL practices of Chinese boxers. Thus, this study aimed to use the RWLQ to examine the WL practices of Chinese amateur boxers for the first time.

Materials and Methods

Experimental Approach to the Problem

An observational cross-sectional study was adopted to questionnaire Chinese amateur boxers and investigate their WL practices. To target the relevant population, this study adopted convenience and snowball sampling.

Participants

Inclusion criteria for this study were participants had to (i) currently train as an athlete on a sports team, (ii) participated in competitive boxing, and (iii) consent to participate in this research. There are no restrictions on the age, sex, and weight class of participants. Participants were initially recruited via a RWLQ link sent to the managers and coaches of Chinese boxing teams through social media platforms (WeChat, Tencent, China), who then shared with their respective athletes.[52] Participants were also recruited via written RWLQs at the Shaolin Tagou Wushu School, China's largest CS training base. The managers and coaches assisted the researcher (YMZ) in recruiting participants during daily sports team meetings, and those who agreed completed a RWLQ collectively in a conference room.[36] Prior to the application of the questionnaire, all participants were orally briefed on what the instrument was, and each senior participant signed the informed consent. For junior boxers the informed assent and consent for parents was granted and signed prior to the application session. During the questionnaire, if participants had any questions, the lead researcher (YMZ) was available to provide an answer. In total, 879 participants completed the RWLQ. The lead author (YMZ) pre-checked all

responses, and 178 participants (20%) were excluded because they had never competed in a boxing match. The boxer's competing experience at different levels (local, provincial, national, international) was determined based on their responses (never participated, participated without winning medal, won a medal) to question 9. Consequently, RWLQ responses from 701 boxers (563 males, 138 females; 489 juniors, 212 seniors) were included in this study, with general information presented in Table 1. Participants were categorized by sex (male, female), age (junior<18 years old, senior≥18 years old), and competitive level (local, provincial, national, international). Approval for conducting the study was secured from the Ethics Committee of the Shanghai University of Sport (number of approval: 102772023RT170).

Insert Table 1 About Here

Questionnaire Administration

Open access questionnaire administration application WJX web platform (WENJUANXING, www.wjx.cn) was used to construct and distribute the online RWLQs and to collect and analyze responses. For paper RWLQs, all data was manually inputted into the WJX web platform for further analysis. The RWLQ by Artioli et al.[22] was used for this study, which has been widely used in CS.[23] The author (YMZ) translated the RWLQ into Chinese, which was checked and agreed upon by (YML). The RWLQ consisted of 23 questions and featured four sections: (i) general information, (ii) competition experience, (iii) weight history, and (iv) WL experience. The content validity of the Chinese version of the RWLQ was evaluated by a researcher with extensive experience in boxing and five boxers through pilot

tests. Pilot testing led to slight modifications to the wording of the RWLQ to ensure its suitability for the targeted audience. Data collection was conducted from 30 November 2023 to 8 May 2024.

Statistical Analyses

All analyses were performed using SPSS 27.0 (IBM Corp., Armonk, NY). Continuous variables were presented in mean and standard deviation, and categorical variables were reported as frequencies (%). Rapid weight loss score (RWLS) is suggested as an assessment score of WL practice, which is higher with the increase of aggressiveness of weight management behaviors.[22] The Shapiro-Wilk test was used to check data normality. Independent t-tests were used to analyze differences in highest WL%, habitual WL%, and RWLS between sexes (male and female) and age groups (junior and senior). Independent t-tests were also used to analyze differences in the age at which boxers began WL practices between sexes. A one-way ANOVA was used to analyze the differences between competitive levels (local, provincial, national, international) for the highest WL%, habitual WL%, annual WL times, and RWLS. A one-way ANOVA was also used to analyze the differences in habitual WL% between allocated WL days (1-3 days, 4-5 days, 4-7 days, 8-10 days, 11-14 days, 15+ days). Cohen's d was calculated for the independent t-test where the values of the effect sizes ($d < 0.20$), (0.21–0.60), (0.61–1.20), (1.21–2.00), (2–4), (>4) were considered trivial, small, moderate, large, very large, or nearly perfect.[53] Omega squared (ω^2) was calculated for the ANOVA where the values of the effect sizes 0.01, 0.06 and above 0.14 were considered small, medium, and large, respectively.[53] Significance was accepted at $p < 0.05$.

Results

The general information of all boxers, as well as boxers who purposefully engaged in WL, is presented in Table 1. Sixty-four percent reported they had not changed their weight category in the past two years. Sixty-seven percent of total boxers (60% of juniors, 83% of seniors) reported that they had purposefully performed WL previously for competition. The results of participant's WL history are displayed in Table 2. Senior boxers usually allocate 15+ days (84%) for BM reduction before competition, followed by 11-14 days (8%), 8-10 days (5%), 6-7 days (3%), 4-5 days (1%), and 1-3 days (0%). Junior boxers similarly allocate 15+ days (69%) for BM reduction before competition, followed by 11-14 days (16%), 8-10 days (6%), 6-7 days (5%), 4-5 days (2%), and 1-3 days (2%). The WL methods used by boxers are shown in Table 3. The influence of other people on participant's WL practices is shown in Table 4.

Insert Table 2-4 About Here

There were no significant differences in habitual WL% and RWLS between junior and senior (p=0.671, 95% confidence interval [CI]: -0.340 to 0.035, d=3.158, p=0.206, 95% CI: -0.349 to 0.025, d=9.602), and between competitive levels (p=0.533, 95% CI: -0.006 to 0.012 ω^2=-0.002, p=0.667, 95% CI: -0.006 to 0.008, ω^2=-0.003). Similarly, there were no significant differences in habitual WL% between sexes (p=0.076, 95% CI: -0.041 to 0.427, d=3.159), and in highest WL% between competitive levels (p=0.465, 95% CI: -0.006 to 0.014, ω^2=-0.001). However, for male Chinese boxers, the highest WL% and RWLS were significantly higher than for females (9.8% vs 8.1%, p<0.001, 95% CI: 0.150 to 0.621, d= 4.319, 28.4 vs 24.9 p=0.002,

95% CI: 0.135 to 0.605, d=9.534). For senior Chinese boxers, the highest WL% and age began WL were higher than juniors (9.1 ± 4.3 vs 10.1 ± 4.4, p=0.018, 95% CI: -0.414 to -0.039, d=-0.001, 14.5 ± 1.2 vs 16.0 ± 1.6, p<0.001, 95% CI: -1.319 to -0.919, d=1.378). There were significant differences in habitual WL% across those allocating different WL time (p=0.002, 95% CI: -0.005 to 0.061, ω^2=0.030), but no difference was found in post-hoc tests. There were no significant differences in the age when WL practices began between sexes (p=0.807, 95% CI: -0.205 to 0.263, d=1.567). The age began WL differs significantly between boxers at different competitive levels (p<0.001, 95% CI: 0.033 to 0.126, ω^2=0.079). Post-hoc tests found that international boxers began WL at later ages compared to local boxers (15.5 years vs. 14.3 years, p=0.012, 95% CI: 0.18 to 2.21), and national boxers began WL at later ages compared to provincial and local boxers (15.6 vs 14.8 years, p<0.001, 95% CI: 0.43 to 1.26, 15.6 vs 14.3 years, p<0.001, 95% CI: 0.64 to 1.98).

Discussion

To our knowledge, this is the first study to explore the prevalence and patterns of WL among Chinese amateur boxers. The primary findings of this study were (i) WL practices are prevalent among Chinese senior boxers but to a lesser extent among junior boxers; (ii) although the prevalence of WL among youth boxers is relatively low, their magnitude of WL is high; (iii) the age when boxers' WL practices began significantly differed across competitive levels and age groups; (iv) the methods most frequently used were increased exercise, training in plastic suits, gradual dieting, training in a heated room, skipping meals, restricting fluid ingestion, and sauna; and (v) boxing coaches, strength and conditioning (S&C) coaches, other boxers, and

parents have the greatest influence on boxers' WL practices, with minimal input from medical or qualified personnel, or academic literature.

In this study, 67% of boxers (60% juniors, 83% seniors; 68% males, 62% females) purposefully engaged in WL practice. A simple comparison of the overall results indicates that the prevalence of WL among Chinese boxers is lower than in most previous studies in other combat sports, including kickboxing (100%),[6] muay Thai (100%),[29] mixed martial arts (MMA) (97%-100%),[24, 25, 28, 38, 54] judo (67-100%),[4, 7, 39-41] sanda (90%),[26] sambo (87-90%),[36, 37, 48] wrestling (83%)[45] and taekwondo (81%),[35] and even in boxing samples from other countries (Italian and English amateur boxers [88%-100%]).[31, 55] However, the participants in previous studies were almost always predominantly adults, while the participants in this study were predominantly young boxers. Therefore, a targeted comparison is necessary. When comparing only adult athletes, the results of this study were similar to those of most previous studies. However, when the young athletes in this study were compared to adult athletes in previous studies, the prevalence was notably lower. The lower overall WL prevalence can be attributed to the high proportion of junior (70% of total participants) boxers among the total participants, some of whom had not yet participated in pre-competition WL, whereas the seniors displayed prevalence more consistent with the wider literature.[56]

Our findings showed that the average habitual WL of participants was 6.0% of BM (5.8% for juniors and 6.3% for seniors), which was higher than in kickboxing (4.9%),[6] wrestling (4.7%),[45] sanda (4.5%),[26] judo (visually impaired) (4.0%),[40] jiu-jitsu (2.3%),[50] judo (2.5-4.0%),[4, 7, 39] taekwondo (3.0%),[35] and amateur boxing (1.8%-4.2%).[31, 55] It was lower only when compared to MMA (6.7-13.0%),[24, 25, 28, 38, 54] sambo (5.2-7.4%),[36, 37, 48] and Muay Thai

(10.6%).[29] Only one study in sambo reported a lower average habitual WL% (5.2%) than current study.[48] Research have shown that athletes in MMA, sambo and Muay Thai engaged in the most extreme WL practice, however in these sports the weigh-in regulations (with weigh-ins occurring the day before competition) allow increased recovery time to implement nutritional strategies to mitigate some of the health and performance detriments associated with WL. This is not the case in amateur boxing, and as such the WL of 6% reported by athletes in this could significantly impact the athlete's performance and health.[9, 57, 58]

In this study, the average highest WL of boxers was 9.5% of BM (9.1% for juniors and 10.1% for seniors). The highest WL for senior boxers in this study was similar to that of athletes previously reported in judo (visually impaired) (10.0%) [40], sambo (10.6%) [37], and sanda (10.3%),[26] but lower than that of athletes in MMA (10.2-17.5%),[25, 28, 54] and muay Thai (13.9%).[29] However, it was higher than that athletes in judo (4.7-6.0%),[4, 7] kickboxing (8.4%),[6] taekwondo (7.3%),[35] and amateur boxing(4.1%-5.5%).[31, 55] Similar trends were observed for junior boxers in this study. Unlike the habitual WL %, the highest WL% of Chinese boxers falls within the medium range compared to the results of aforementioned studies. The highest WL% of this study was 4.6% higher than the previous results in Italian amateur boxers (5.5%).[31] This highlights the variations in practice between athletes from different countries.

Although the prevalence of WL was lower in junior boxers in this study compared to senior CS athletes in this study and aforementioned studies, the magnitude of WL in these junior boxers was similar to or higher than many previously referenced studies. This is particularly concerning given the high magnitude of WL under the specific age (<18 years old) and competition rule set in Olympic boxing, which requires athletes to weigh-in on the morning

of the first competition day and each subsequent day they compete. In contrast, the official weigh-in for MMA, Sambo and Muay Thai all take place one day before competition,[59-61] allowing athletes significant recovery time for athlete after severe WL practices. However, in amateur boxing, athletes weigh in on the morning of the competition day, making full recovery more challenging. Additionally, Sambo and MMA only require athletes to weigh once before competing, while amateur boxing needs athletes to weigh in the morning of each competition day. Compared to other sports with the similar weigh-in rules, the magnitude of WL of these boxers were much higher, as shown in the earlier comparisons, highlighting the severity of WL practices among these boxers.

This study found that the highest WL% was significantly greater in males (9.8%) than in females (8.1%), which was consistent with previous findings that female CS athletes' WL practices are more conservative than those of their male counterparts.[36] Additionally, the highest WL% among junior boxers (9.1%) were significantly lower than that of senior boxers (10.1%), which also align with previous finding.[23, 62] There are two possible explanations for this phenomenon. First, senior athletes are physically more mature and therefore able to withstand the negative impacts associated with greater WL%. Second, the competition in the senior group tends to be more intense, and the differences in competitive ability between athletes are smaller (or at least smaller than those in the junior group), necessitating the need to gain an advantage through methods other than training to improve their chances of winning.

Most (84 for senior and 69% for junior) participants began to lose weight 15+ days before a competition. The percentage of participants who allocated 15+ days for WL was higher than in previous studies reporting allocated WL time outcomes using a categorical format.[7, 39, 50, 51]

This may be due to the preference of these boxers for chronic methods to loss BM, such as increased exercise, and gradual dieting. Although MMA and sambo athletes had a higher habitual WL%, their allocated WL days were generally shorter (e.g., an average of 11 days was reported in all three sambo studies).[36, 37, 48] This may reflect that these boxers are using more sustainable weight loss strategies, as adequate time is necessary to mitigate the adverse effects caused by WL, especially at high magnitudes. Recent studies have reported that a taekwondo athlete lost 13.5% BM (10kg) using sustainable methods over 8 weeks, resulting in no health and performance consequences,[63] whereas another case study of a MMA athlete reported losing 18.1% of BM (14 kg) in 8 weeks (primarily through dehydration) dramatically affected health and performance variables.[64] Further analysis found a significant difference among boxers regarding the number of days used to achieve their habitual WL%. One logical explanation for this phenomenon is that athletes may adjust the time devoted to WL according to the required magnitude in order to minimize the effects of WL. This may guide future research to investigate whether the same "WL% x time" (e.g., lose 5% BM in 7 days and 10% in 14 days) leads to similar physiological, psychological, and performance effects. Such research will enhance our understanding of WL and distinguish between chronic and rapid WL practices.

The average age that WL practices began was 15.1 years old (14.5 years old for juniors and 16.0 years old for seniors), which was similar to previous findings in sambo (14.9-16.0 years old),[36, 37, 48] but higher than in judo (12.5-12.6 years old),[4, 7] and younger than in visually impaired judo (20.6 years old),[40] MMA (19.0-21.0 years old),[25, 28] wrestling (19.2 years old),[45] kickboxing (18.5 years old),[6] taekwondo (17.7 years old),[35] sanda (18.8 years old),[26] and boxing (18.4 years old).[31] This indicates that Chinese boxers began WL practices at an earlier age than

most CS athletes from other countries and sports. A recent review suggests that CS athletes previously studied did not engage in WL at the age they first began competing but rather several years later.[23] In contrast, This study found that Chinese boxers, on average, started to engage in WL practices within half a year after their first competition, which was 14.6 years old (first competition) and 15.1 years old (beginning WL practices), respectively. The age when international Chinese boxers began using WL practices was 15.5 years old, which was significantly higher than local boxers (14.3 years old). Furthermore, the age when WL practices began for national Chinese boxers was 15.6 years, which was significantly higher than provincial (14.8 years old) and local boxers. Interestingly, international and national Chinese boxers adopt WL practices at a later age, suggesting that starting WL earlier does not make boxers stand out in competition achievement. Studies have shown that intentional energy deficits and dehydration during physical training and competition in childhood or adolescence can disturb metabolic and hormonal regulations affecting growth, maturation, body composition, menstrual cycles and reproductive capacity.[65] Another study also found that female judo athletes who experienced weight loss during the development of secondary sexual characteristics were significantly shorter in height than those who did not.[66] Based on this evidences, we can reasonably hypothesize that athletes who began WL earlier may be more adversely affected in terms of health and development,[62, 65, 67, 68] potentially negatively affecting their long-term achievement.

Boxers reported increased exercise (85.5%), training in plastic suits (69.8%), gradual dieting (56.1%), training in a heated room (54.7%), skipping meals (50.9%), restricting fluid ingestion (48.3%), and using sauna (43.4%), as the most frequently used WL practices (see

Table 3). This finding aligns partially which indicate that increased exercise is the most commonly utilized method among CS athletes.[23] Training in plastic suits was higher than in prior research, where a gradual dieting (calorie deficit) was most frequently used method.[23] However, over-reliance on increased exercise for WL may negatively impact an athlete's pre-competition status due to the additional training load (such as mental and physical fatigue), thereby increasing the risk of injury and decreased competitive performance.[69] It is worth noting that some potentially harmful methods (fasting, laxatives, diuretics, diet pills, vomiting) were reported, albeit less frequently (see Table 3). A recent case study has shown that effective weight manipulation can be achieved with minimal effects on athlete health and reduced additional training load.[63] Furthermore, guidance on more appropriate dietary interventions has been available in the literature for several years.[70-72] However, utilizing these studies would require individuals with a certain level of academic training which may not be readily accessible in CS gyms or sports training centers in general.

Consistent with previous findings,[23] sports coaches (56%), S&C coaches (37.9%), other boxers (37.5%), and parents (34.7%) had the highest influence on boxers' WL practices, while doctors, nutritionists, journal articles, books/magazines, and online resources are considered to have minimal impact. To our knowledge, CS teams in China do not systematically provide education and support for WL, with resources available to sports teams for WL are limited. CS training and performance are centered around independent gyms and training centres, often run by small teams of technical coaches or sometimes a single coach. As such it is rare for CS gyms to have medically or scientifically trained athlete support. Thus, it is not surprising that coaches were found to have the highest influence on this process, a finding that aligns with the results

from the majority of RWLQ studies in other sports.[23] This guidance may rely on personal experience and anecdotal evidence, due to the minimal influence of qualified personnel. However, one study found no association between nutritional knowledge and WL behavior in boxers, suggesting that personal experience may not adequately substitute for support qualified practitioner support.[55] This may be further exasperated by the nature of the CS training environment, where one coach may be responsible for the preparation of 30+ athletes at once. One coach in this study who shared insights during data collection (which was not specifically gathered for this study but proved valuable), stated, "*Even if I had enough nutritional knowledge about WL practices, I would not have enough time to develop individual diet and training strategies for 50 athletes*". This highlights that an athlete's adoption, adherence, support, and knowledge regarding WL practices may ultimately depend on the amount of support available, alongside the education of the coach. Given the influence of coaches on athletes, targeting them for educational initiatives may yield a better 'return on investment' compared to attempts to connect athletes with health professionals. Interestingly, the influence of parents this study was higher than previously reported and exceeded that of other influencer, aside from sports coaches, S&C coaches and other boxers. This finding aligns only with a prior study investigating adolescents participating in competitive judo.[4] This may be because the boxers engaged in WL in this study included 63% of juniors, which seems to indicate that parents are more likely to influence the WL practice of juniors than seniors.

In this study, the boxer's RWLS was 27.7 (27.2 for juniors and 28.7 for seniors), lower than almost all other CS including Judo (28-31.5),[7] MMA (35.1-54),[24, 25, 28] kickboxing (52.4),[6] muay Thai (54.3),[29] wrestling (39.1-30.3),[45] and multi-CS (30.6-34.7).[30, 44, 46] The RWLS

indicates that the WL practices of Chinese boxers were less severe than that of other CS athletes. However, the habitual WL% and highest WL% of participants in this study were higher than most aforementioned studies investigating CS athletes, suggesting that the WL practices of Chinese boxers were more severe, which seems to conflict with RWLS. Interestingly, RWLS integrates other variables such as the age when WL practices began, allocated WL days, and WL methods; thus, Chinese boxers demonstrated less aggressive practices overall. This study found no differences in RWLS between age groups and competitive levels, but notable differences were observed between sexes. This difference may be misleading however, as the magnitude of WL is a key component of the RWLS and is counted in kg, not as BM%. Therefore, females generally weigh less than males, resulting in a higher RWLS in male boxers when losing the same BM%. Therefore, future research could benefit from developing a formula to account for these differences, allowing more appropriate sex comparisons.

Limitations

This study has two main limitations. Firstly, non-probability convenience and snowball sampling were employed. Considering that China comprises 34 provinces/municipalities, a design allowing an equal probability of athletes' selection from all over the country would be impractical. Consequently, we cannot entirely ensure that the sample population in the present study is representative of all Chinese boxers. Secondly, for further in-depth research based on interviews in the future, the questionnaire was non-anonymous, which may result in dishonest answers from athletes. Considering that in-depth interview research is scarce in the literature, particularly regarding the WL experiences of world-class boxers, this non-anonymous design

was deemed necessary.

Conclusion

WL practices are prevalent among Chinese senior boxers but to a lesser extent in junior boxers. Although the prevalence of WL among junior boxers was relatively low, their magnitude of WL was high. Chinese boxers tend to allocate a relatively longer duration (15+ days) to lose a high percentage of their BM. Most of the significant differences in WL practices were observed on sex and age group rather than competitive level. The most frequent WL method used by Chinese boxers was increased exercise, training in plastic suits, gradual dieting, training in a heated room, skipping meals, restricting fluid ingestion, and sauna. Additionally, the influence of non-professionals (such as coach and parents) on boxers' WL practice is greater than that of professionals (such as doctor and nutritionist). It is essential to educate coaches and athletes about WL, highlighting the need for or research into WL education programs.

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Data availability statement.

All data are available on reasonable request

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Table 1. General information of Chinese boxers.

Variables	All participants (n=701)			Participants who engaged in weight loss (n=470)		
	Mean ± SD	Max	Min	Mean ± SD	Max	Min
Age (years)	17.3 ± 3.2	36	7	17.8 ± 3.4	36	13
Body mass (kg)	66.6 ± 13.9	130.0	30.0	65.9 ± 11.7	130.0	43.0
Stature (cm)	174.4 ± 7.9	198	134	174.7 ± 7.0	194	155
Age began training in boxing (years)	13.2 ± 1.6	18	6	13.2 ± 1.6	17	6
Age began competing in boxing (years)	14.4 ± 1.3	19	7	14.5 ± 1.3	19	9
Off-season weight (kg)	66.4 ± 13.7	130.0	30.0	66.0 ± 11.6	130.0	43.0

Table 2. Weight loss history of Chinese boxers who had previously used weight loss practices (n=470).

Variables	Total (n=470)	Male (n=384)	Female (n=86)	International (n=23)	National (n=150)	Provincial (n=251)	Local (n=46)	Junior (n=295)	Senior (n=175)
Highest weight loss (kg)	6.3 ± 3.3	6.7 ± 3.4	4.8 ± 2.2	6.3 ± 3.9	6.7 ± 3.4	6.3 ± 3.3	5.8 ± 3.3	6.0 ± 3.4	6.9 ± 3.2
Highest weight loss (%)	9.5 ± 4.4	9.8 ± 4.5	8.1 ± 3.4*	8.9 ± 5.0	9.9 ± 4.3	9.4 ± 4.3	8.9 ± 4.5	9.1 ± 4.3	10.1 ± 4.4*
No. weight losses in the last year	1.5 ± 1.0	1.5 ± 1.0	1.4 ± 0.9	1.4 ± 1.3	1.7 ± 1.1	1.4 ± 0.9	1.2 ± 0.8	1.5 ± 0.8	1.4 ± 1.2
Habitual weight loss (kg)	4.0 ± 2.2	4.1 ± 2.3	3.3 ± 1.7	3.8 ± 2.4	3.9 ± 2.0	4.1 ± 2.3	3.8 ± 2.0	3.8 ± 2.2	4.3 ± 2.1
Habitual weight loss (%)	6.0 ± 3.2	6.1 ± 3.2	5.5 ± 2.8	5.4 ± 3.3	5.8 ± 3.0	6.2 ± 3.3	5.9 ± 3.0	5.8 ± 3.1	6.3 ± 3.3
Age began weight loss (yr)	15.1 ± 1.6	15.1 ± 1.5	15.0 ± 1.7	15.5 ± 1.8	15.6 ± 1.8	14.8 ± 1.3[b]	14.3 ± 1.7[ab]	14.5 ± 1.2	16.0 ± 1.6*
Post-competition weight regains (kg)	3.2 ± 1.6	3.3 ± 1.6	2.7 ± 1.5	3.1 ± 2.1	3.1 ± 1.5	3.2 ± 1.6	3.3 ± 1.6	3.1 ± 1.6	3.3 ± 1.6
Post-competition weight regains (%)	4.8 ± 2.3	4.9 ± 2.3	4.7 ± 2.5	4.5 ± 3.1	4.7 ± 2.3	4.9 ± 2.3	5.1 ± 2.2	4.8 ± 2.3	4.9 ± 2.4
RWLS	27.7 ± 9.6	28.4 ± 9.8	24.9 ± 8.0*	29.1 ± 9.8	27.8 ± 8.5	27.4 ± 9.7	29.0 ± 12.4	27.2 ± 9.8	28.7 ± 9.2

Note: RWLS: rapid weight loss score. Only the highest weight loss (%), habitual weight loss (%), age began weight loss, and RWLS were analyzed using inferential statistics. * = differences between sexes and age groups ($P<0.05$). [a] =differences from international level Boxer ($P<0.05$). [b] =differences from national level Boxer ($P<0.05$).

Table 3. Frequency analysis (%) of the weight loss methods used by Chinese boxers (n=470).

	Always	Sometimes	Almost Never	Never Used	Do Not Use Any More
Gradual dieting	22.3	33.8	21.9	16.4	5.5
Skipping meals	13.0	37.9	29.4	13.8	6.0
Fasting	3.2	9.8	23.8	56.2	7.0
Restricting fluid ingestion	15.1	33.2	24.5	22.3	4.9
Increased exercise	50.2	35.3	8.1	4.9	1.5
Training in a heated room	24.5	30.2	18.5	24.9	1.9
Sauna	15.5	27.9	19.4	35.1	2.1
Training in plastic suits	35.1	34.7	15.1	12.8	2.3
Use plastic suit all-day	6.2	13.8	23.4	55.1	1.5
Spitting	5.3	13.2	21.3	58.7	1.5
Laxatives	1.3	1.9	9.8	84.5	2.6
Diuretics	1.1	2.3	8.3	86.4	1.9
Diet pills	0.9	1.5	7.5	88.3	1.9
Vomiting	1.7	6.0	14.0	74.9	3.4
Hot water immersion	6.0	16.6	17.9	57.7	1.9
Hot salt-water immersion	1.3	4.3	11.9	80.9	1.7
Others	4.0	3.6	8.9	81.1	2.3

Table 4. Frequency analysis (%) of the sources of influence on the weight loss practices of Chinese boxers (n=470).

	Very influential	Some influence	Unsure	Little influence	Not influential
Other athletes (different sports)	2.8	13.6	17.0	20.2	46.4
Other athletes (same sport)	8.1	29.4	13.8	22.6	26.2
Doctors	5.1	13.6	18.3	16.6	46.4
Strength and conditioning coaches	15.1	22.8	14.7	16.2	31.3
Coaches	31.5	24.5	6.8	13.4	23.8
Parents	9.8	24.9	11.1	17.5	36.8
Nutritionists	4.7	17.9	15.3	16.0	46.2
Journal articles	2.8	10.0	16.2	15.1	56.0
Book/magazines	2.6	10.0	15.5	16.8	55.1
Internet sources	4.7	16.6	15.1	18.1	45.5
Others	2.3	7.2	17.5	12.8	60.2