Appendix A Study Summary

Author: Evans (1989)
Title: The Effect of Chromium Picolinate on Insulin Controlled Parameters in Humans

1. Location and Funding	Bemidji State University, Minnesota, USA (no statement of funding provided)
2. Study Objectives	Four studies were conducted to evaluate the efficacy of chromium picolinate in potentiating insulin action in three difference metabolic pathways.
3. Number of Subjects Description	10 Males (study one) & 31 Males (study two) Students from Bemidji State University, age range18-21 years (study one) Football Players from Bemidji State University (study two)
4. Chromium Type and Dosage (Brand)	200 $\mu g \cdot d^{-1}$ Chromium Picolinate (no brand stated)
5. Exercise Training (frequency)	Resistance (2 $d \cdot wk^{-1}$) – (study one) Resistance (4 $d \cdot wk^{-1}$) – (study two)
6. Duration of Study	40 days (study one) 42 days (study two)
7. Controlling of Bias	• Random assignment of subjects to treatment groups • Double-blind design • Jadad 3-item quality assessment score: 1/5 (study one) 3/5 (study two)
8. Variables Measured & Analytical Technique	• **Body weight** • **Percentage body fat** (Sum of triceps, subscapular and chest skinfolds) • **Fat mass** • **Lean body mass** (Determined by: weight – weight *x* percentage fat) • **2-site circumference** (biceps and calf)
9. Statistical Analysis	Paired *t*-tests were used to identify statistically significant differences between mean values of changes and differences in changes in each case study.
10. Results	Study One Total body weight significantly increased in both chromium and placebo groups, this was due to increase in lean body mass in chromium group, compared to an increase in fat mass in the placebo group. Study Two A slight non-significant decrease in body weight in both chromium and placebo groups. However, fat mass was significantly reduced and lean body mass significantly increased in the chromium group, compared to no significant changes in body composition parameters in the placebo group.
11. Conclusion	Experimental observations demonstrate that chromium picolinate supplements effect at least three areas of metabolism regulated by insulin. This includes prevention of hyperlipidemia, a factor in coronary heart disease and insulin sensitivity related to non-insulin dependent diabetes mellitus (NIDDM). Also chromium supplementation is effective at enhancing muscle accretion and body fat reduction in individuals participating in intensive weight training.

Appendix A Study Summary

Author: Hasten et al. (1992)
Title: Effects of Chromium Picolinate on Beginning Weight Training Students

1. Location and Funding	Louisiana State University, Baton Rouge, Louisiana, USA. (no statement of funding provided).
2. Study Objectives	Preliminary investigation designed to assess both body composition and strength effects of chromium picolinate supplementation on beginning weight-training students, female and male, over a 12-week period.
3. Number of Subjects Description	59 Male and 22 Female Students from Louisiana State University, age range 18-36 years
4. Chromium Type and Dosage (Brand)	200 $\mu g \cdot d^{-1}$ Chromium Picolinate (brand not stated)
5. Exercise Training (frequency)	Resistance (3 $d \cdot wk^{-1}$)
6. Duration of Study	12 weeks
7. Controlling of Bias	• Subjects randomly assigned to treatment groups • Double-blind design • Jadad 3-item quality assessment score: 3/5
8. Variables Measured & Analytical Technique	• **Body weight** (Scale, accurate to ± 0.1 kg) • **Lean Body Mass** (sum of circumference measures) • **Sum of 3-Circumference** (Chest, Arm, Thigh) • **Sum of 3-Skinfolds** (Triceps, suprailiac, thigh – females, pectoral, abdominal, thigh – males) • **Strength** (Squat and Bench Press one-repetition maximum - 1RM)
9. Statistical Analysis	2 x 2 x 5 factorial ANOVA for treatment, gender and time with repeated measures over time. Significance level, $p = 0.05$.
10. Results	Females receiving chromium picolinate significantly gained 2.5 kg more bodyweight than all three other groups (F-P, M-CrPic and M-P). No other variables showed significant change beyond that due to training alone.
11. Conclusion	Chromium Picolinate supplementation as 200 $\mu g \cdot d^{-1}$ was shown to be beneficial in terms of weight gain for beginning female weight-lifting students but not for their male counterparts.

Appendix A Study Summary

Author: Clancy et al. (1994)
Title: Effects of Chromium Picolinate Supplementation on Body Composition, Strength, and Urinary Chromium Loss in Football Players

1. Location and Funding	University of Massachusetts, Amherst, Massachusetts, USA. (no statement of funding provided)
2. Study Objectives	Examine the effects of chromium picolinate supplementation on lean body mass and strength in football players during their off-season strength-training program. Urinary chromium excretion levels were also examined to provide information on urinary chromium loss for these athletes.
3. Number of Subjects Description	21 Football Players (Gender not provided) University of Massachusetts Football Players
4. Chromium Type and Dosage (Brand)	200 $\mu g \cdot d^{-1}$ Chromium Picolinate (Chromic Fuel, Twin Labs, Ronkonkona, New York).
5. Exercise Training (frequency)	Resistance training (4 $d \cdot wk^{-1}$), Running exercise (2 $d \cdot wk^{-1}$)
6. Duration of Study	9 Weeks
7. Controlling of Bias	• Subjects randomly assigned to placebo or chromium groups. • Double-blind design. • Reasons provided for subject withdrawals. • Jadad 3-item quality assessment score: 4/5
8. Variables Measured & Analytical Technique	• **Body mass** • **Lean body mass & Percentage body fat** (hydrostatic weighing) • **20-site Circumference measures** • **7-site Skinfold thickness** • **Strength** (Isometric and dynamic strength of elbow and knee flexors and extensors) • **Urinary chromium excretion** (atomic absorption spectrophotometry)
9. Statistical Analysis	Paired *t*-test to assess differences between mean circumference of left and right limbs. Two factor, repeated measures ANOVAs were performed on all criterion measures to determine significant group (chromium versus placebo) interactions over the three trials (pre-, mid-, post-).
10. Results	There were no significant effects of chromium supplementation on any variables measured, with the exception of an increase in urinary chromium excretion in supplemented individuals.
11. Conclusion	The results showed that 200 $\mu g \cdot d^{-1}$ chromium picolinate given to football players during strength training increased urinary chromium excretion, but did not affect strength or muscle development.

Appendix A Study Summary

Author: Trent et al. (1995)
Title: Effects of Chromium Picolinate on Body Composition

1. Location and Funding	Naval Health Research Centre, San Diego, California, USA. (Supported by the Nutrition 21, Bureau of Naval Personnel, The Naval Medical Research and Development Command).
2. Study Objectives	The objectives of the study were to evaluate the potential of chromium picolinate as a weight-reduction agent to the Navy's remedial conditioning programs.
3. Number of Subjects Description	79 Male and 16 Female Healthy, active-duty Navy personnel who exceeded the Navy's percentage body fat standards of 22% for men, 30% for women. Mean age 30.3 years.
4. Chromium Type and Dosage (Brand)	400 $\mu g \cdot d^{-1}$ Chromium Picolinate (brand not stated)
5. Exercise Training (frequency)	From exercise log-book analysis, participants exercised an average of 4.5 hrs $\cdot wk^{-1}$, 3 hours of which were devoted to aerobic exercise with the remainder on anaerobic exercise.
6. Duration of Study	16 Weeks
7. Controlling of Bias	• Double-blind design • Reasons provided for withdrawals • Jadad 3-item quality assessment score: 3/5
8. Variables Measured & Analytical Technique	• **Body weight** • **Percentage body fat** (neck & abdomen circumference for males, neck, waist & hip for females) • **Lean body mass** • **Diet & Exercise** (end-of-study questionnaire & log-books) • **Mood & Sleep quality**
9. Statistical Analysis	No statement provided.
10. Results	No significant differences at baseline or post-test in exercise habits, dietary habits, sleep and mood patterns or body composition (body weight, percentage body fat or lean body mass.
11. Conclusion	This study failed to support the efficacy of chromium picolinate supplementation for enhancing body fat loss in conjunction with an aerobic exercise program.

Appendix A Study Summary

Author: Hallmark et al. (1996)
Title: Effects of Chromium and Resistive Training on Muscle Strength and Body Composition.

1. Location and Funding	University of Maryland, Maryland, USA. (no statement of funding provided)
2. Study Objectives	Assess the effects of chromium picolinate supplementation and a progressive resistive exercise-training program on muscle strength, body composition and chromium excretion in young, untrained male subjects.
3. Number of Subjects Description	16 Males Healthy, untrained males aged between 18-35 years. Mean body weight 82 ± 3 kg.
4. Chromium Type and Dosage (Brand)	200 $\mu g \cdot d^{-1}$ Chromium Picolinate (Nutrition 21, San Diego, California).
5. Exercise Training (frequency)	Resistance ($5\ d \cdot wk^{-1}$)
6. Duration of Study	12 Weeks
7. Controlling of Bias	• Subjects randomly assigned to placebo or chromium groups. • Double-blind study design. • Jadad 3-item quality assessment score: 3/5
8. Variables Measured & Analytical Technique	• **Body weight** • **Percentage body fat, Fat mass, Lean body mass** (hydrostatic weighing) • **Skinfold** (chest, scapula, triceps, midaxillary, suprailiac and abdomen) • **Circumference** (chest, biceps, abdomen, hips and thigh) • **Strength** (1RM – leg press & extension, chest press, lat pulldown, seated rows and overhead press) • **Urinary chromium excretion** (atomic absorption spectrophotometry)
9. Statistical Analysis	Repeated-measures ANOVA to determine effects of time and chromium supplementation on dependent variables. Significance level, $p = 0.05$. Post-hoc analysis on selected treatment with Bonferroni Adjustment to significance level.
10. Results	No significant group changes in body composition. Significant increase in strength in both groups, however, no additional effect of chromium on strength above that of resistance training alone. Chromium associated with significant increase in urinary chromium excretion in supplemented individuals.
11. Conclusion	12-weeks of progressive resistive exercise training resulted in equivalent improvements in upper and lower body muscle strength in both the chromium and placebo groups. Chromium supplementation did not result in significant alterations of body composition compared to placebo group. Chromium picolinate supplementation resulted in a significant increase in chromium excretion, which was not altered by chronic resistive exercise training.

Appendix A Study Summary

Author: Kaats et al. (1996)
Title: Effects of Chromium Picolinate Supplementation on Body Composition: A Randomised, Double-Masked, Placebo-Controlled Study

1. Location and Funding	Health and Medical Research Foundation, San Antonio, Texas, USA. (Funded by Living at Goal Weight Center, Optimal Health Products and Nutrition 21).
2. Study Objectives	To examine the effects of supplementation with chromium picolinate on improvement in body composition as measured by densitometry.
3. Number of Subjects Description	154 Subjects (male and female) Free-living subjects, mean age 46.3 years of original sample (n = 219)
4. Chromium Type and Dosage (Brand)	200 or 400 $\mu g \cdot d^{-1}$ Chromium Picolinate, combined with carbohydrate (10g fructose) and protein (14g egg white). (Vitex Foods, Inc, Los Angeles, California).
5. Exercise Training (frequency)	No attempt made to alter dietary of exercise habits, subjects described as "free-living".
6. Duration of Study	90-days (~13 weeks)
7. Controlling of Bias	• Subjects randomly assigned to placebo, 200 or 400 $\mu g \cdot d^{-1}$ chromium groups. • Double-blind study design. • Jadad 3-item quality assessment score: 3/5
8. Variables Measured & Analytical Technique	• **Body weight** (scales, accurate to 1/10 pound) • **Percentage body fat, Fat mass, Non-fat weight** (Water Displacement Method)
9. Statistical Analysis	Drop-out rates were analysed with Chi-square. Comparisons between groups were made using single-factor ANOVA. Paired t-test was used for comparison between group variables.
10. Results	Significant decrease in percentage body fat, fat weight and body composition improvement in 200 μg chromium group compared to placebo. Significant decrease in body weight, percentage body fat, fat weight and body composition improvement in 400 μg chromium group compared to placebo. No significant difference between change in lean body mass of placebo, 200 and 400 μg chromium groups. No significant difference between change in any body composition parameters of 200 and 400 μg chromium groups.
11. Conclusion	The data suggests that supplementation with chromium picolinate can lead to significant improvements in body composition when body composition improvement (BCI) is used as the outcome criterion that represents a sum of the net gains in non-fat mass added to the sum of net losses in body fat.

Appendix A Study Summary

Author: Lukaski et al. (1996)
Title: Chromium Supplementation and Resistance Training: Effects on Body Composition, Strength, and Trace Element Status of Men.

1. Location and Funding	US Department of Agriculture and the University of North Dakota, Grand Forks, North Dakota, USA. (no statement of funding provided).
2. Study Objectives	Examine the effects of the chemical form of chromium supplementation (chromium picolinate and chromium chloride) on whole-body and regional-body composition, including muscle mass and bone, and strength gains of young males participating in a controlled resistance training program and matched for initial strength, body physique and serum chromium concentration.
3. Number of Subjects Description	36 Males Not actively involved in physical training, aged 19-29 years.
4. Chromium Type and Dosage (Brand)	182 $\mu g \cdot d^{-1}$ Chromium Chloride, 171 $\mu g \cdot d^{-1}$ Chromium Picolinate. (Nutrition 21, San Diego, California).
5. Exercise Training (frequency)	Resistance (5 $d \cdot wk^{-1}$)
6. Duration of Study	8-Weeks
7. Controlling of Bias	• Double-blind study design • Jadad 3-item quality assessment score: 2/5
8. Variables Measured & Analytical Technique	• **Body weight** (scale, accurate to ± 0.2 kg) • **Skinfold thickness** (biceps, triceps, subscapular and suprailiac) • **Percentage body fat Fat mass, Fat-free mass, Mineral-free mass** (Dual X-ray Absorptiometry) • **Serum chromium concentration & Urinary chromium excretion** (graphite-furnace atomic absorption spectrophotometry) • **Hematocrit and Haemoglobin** (Coulter model S) • **Creatinine excretion** (Cobas Fara centrifugal analyser) • **Plasma iron & Total-iron-binding capacity** (Zeeman graphite-furnace atomic-absorption spectrometry) • **Nutrient Intake** (3-d dietary records) • **Strength** (1RM – bench press, lateral pull, leg press and curl).
9. Statistical Analysis	3 x 2 repeated measures ANOVA was used to examine effects of chromium supplementation and resistance training on body composition, strength, blood and urine trace element indexes. Post-hoc Tukey test used to identify between which treatment groups significant differences were present.
10. Results	No effect of chromium supplementation on assessments of on body weight, body physique, composition, regional-body composition, strength, hematocrit or haemoglobin concentration. Supplementation with chromium was associated with a significant increase in serum chromium concentration and increased urinary chromium excretion.

11. Conclusion	Chromium supplementation of young men participating in a controlled strength-training program elicited no beneficial effects on muscle accretion, fat loss or strength gains. It may be hypothesised that beneficial effects of chromium supplementation will occur only in individuals with impaired chromium nutriture.

Appendix A Study Summary

Author: Grant et al. (1997)
Title: Chromium and Exercise Training: Effect on Obese Women

1. Location and Funding	University of Texas, Austin, Texas, USA. (Grant from Shaklee, USA, Inc., San Francisco, California).
2. Study Objectives	To study the effects of chromium supplementation as chromium picolinate on young, obese women had tow objectives: first, to determine if chromium picolinate supplementation alone favourably alters body weight and composition, glucose tolerance and plasma lipids, and whether these could be augmented with exercise training and second, to provide data on efficacy of chromium nicotinate combined with exercise.
3. Number of Subjects Description	43 Females Healthy, sedentary, obese, aged 18-35 years, weight 50.8 to 96.1 kg.
4. Chromium Type and Dosage (Brand)	400 $\mu g \cdot d^{-1}$ Chromium Nicotinate or Chromium Picolinate (Prepared by Shaklee, Inc., San Francisco, California, USA).
5. Exercise Training (frequency)	Step aerobics (2 $d \cdot wk^{-1}$), Cycling – 75-80% maximal heart rate (2 $d \cdot wk^{-1}$), Resistance training (2 $d \cdot wk^{-1}$).
6. Duration of Study	9-Weeks
7. Controlling of Bias	• Subjects randomly assigned to one of four treatment groups. • Jadad 3-item quality assessment score: 1/5
8. Variables Measured & Analytical Technique	• **Body weight** (scale, accurate to ± 0.2 kg) • **Percentage body fat, Fat mass and lean body mass** (Hydrostatic weighing) • **Glucose and Insulin response** (oral glucose tolerance test, OGTT) • **HDL-c, LDL-c and Total Cholesterol**
9. Statistical Analysis	A multivariate ANOVA was run for each variable on pre- and post-values across all treatment groups.
10. Results	Significant body weight gain in the chromium picolinate, non-exercising group compared to pre-supplementation. Significant decrease in body weight in the chromium nicotinate, exercise group compared to pre-training/supplementation. Chromium nicotinate, exercise group demonstrated a significant decline in the insulin response at 60, 90 and 120 minutes post OGTT, which resulted in an overall decline in the insulin response curve. This was not however associated with a change in the serum glucose concentration compared to pre-treatment.
11. Conclusion	Chromium picolinate supplementation resulted in an increase in body weight, whilst training combined with chromium nicotinate supplementation resulted in weight loss and a lower insulin response to an oral glucose load, suggestive of increased glucose sensitivity.

Appendix A Study Summary

Author: Kaats et al. (1998)
Title: A Randomised, Double-Masked, Placebo-Controlled Study of the Effects of Chromium Picolinate Supplementation on Body Composition: A Replication and Extension of a Previous Study.

1. Location and Funding	Health and Medical Research Foundation, San Antonio, Texas, USA. (Supported by Nutrition 21, Inc., San Diego, California).
2. Study Objectives	To examine the effects of chromium picolinate supplementation on improvement in body composition as measured by dual x-ray absorptiometry, controlled for differences in physical activity and calorie intake and use of a methodological technique to reduce the drop-out rate.
3. Number of Subjects Description	17 Males, 105 Females Members of fitness and athletic clubs in San Antonio and Houston, Texas. Mean age 42.3 years.
4. Chromium Type and Dosage (Brand)	400 $\mu g \cdot d^{-1}$ Chromium Picolinate (brand not stated)
5. Exercise Training (frequency)	None prescribed, subjects required during waking hours to assess energy expenditure.
6. Duration of Study	92-days (~13 weeks)
7. Controlling of Bias	• Subjects randomly assigned to placebo or chromium groups. • Double-blind study design. • Explanation of subject withdrawals • Jadad 3-item quality assessment score: 5/5
8. Variables Measured & Analytical Technique	• **Body weight** • **Percentage body fat, Fat mass, Fat-free mass** (Dual X-ray Absorptiometry) • **Energy intake** (dietary record) • **Energy expenditure** (pedometer)
9. Statistical Analysis	Comparisons between body composition variables for the placebo and chromium groups at baseline using a two-tailed Student *t*-test and between baseline and post-tests for both groups using a paired *t*-test. Comparison of changes in body composition variables from baseline to post-test study using analysis of covariance (ANCOVA).
10. Results	Placebo and chromium groups both demonstrated a significant reduction in body weight, percentage body fat and fat mass compared to baseline. The chromium supplemented group reduced fat mass significantly more than the placebo group. Adjustment for caloric intake and expenditure revealed that when net energy intake was controlled, the chromium group significantly reduced body weight, percentage body fat and fat mass compared to placebo.
11. Conclusion	Supplementation with chromium can lead to significant improvements in body composition, particularly when the changes are corrected for differences in caloric intake and expenditure.

Appendix A Study Summary

Author: Walker et al. (1998)
Title: Chromium Picolinate Effect on Body Composition and Muscular Performance in Wrestlers.

1. Location and Funding	University of Oklahoma, Oklahoma, USA. (Partially funded by the Gatorade Sports Science Institute and the University of Oklahoma Graduate College).
2. Study Objectives	To study the effects of 14-weeks of chromium picolinate supplementation during the final 16-weeks of a preseason resistance and conditioning program on body composition and neuromuscular performance in NCAA Division 1 Wrestlers.
3. Number of Subjects Description	20 Male NCAA Division 1 varsity wrestlers aged 18-23 years, from the University of Oklahoma.
4. Chromium Type and Dosage (Brand)	200 $\mu g \cdot d^{-1}$ Chromium Picolinate (brand not stated)
5. Exercise Training (frequency)	Resistance (3 $d \cdot wk^{-1}$)
6. Duration of Study	14-weeks
7. Controlling of Bias	• Random assignment of subjects to placebo or chromium groups. • Double-blind study design. • Control group in addition to placebo group. • Compliance of exercise and chromium monitored. • Statement of withdrawals • Jadad 3-item quality assessment score: 5/5
8. Variables Measured & Analytical Technique	• **Body Weight** • **Lean body mass, Fat mass and Percentage body fat** (Hydrostatic weighing) • **Skinfold thickness** (abdominal, biceps, chest, calf, midaxillary, subscapular, suprailium, thigh, triceps) • **Circumference** (abdomen, calf, forearm, hips, arm, waist, thigh, shoulders, chest, neck) • **Maximal aerobic power** (Treadmill – Bruce protocol) • **Peak anaerobic power** (Windgate 30s cycle ergometer test) • **Strength** (1RM – bench press) • **Endurance** (maximal repetitions of seated low-pulls and leg press) • **Muscle power** (Olympic power clean) • **Fasting glycaemic levels & Serum insulin concentrations** • **Nutrient intake** (3-d dietary records)
9. Statistical Analysis	Two-way repeated measures ANOVA (group x trial) was used to determined whether differences existed between groups, trials, and possible existence of group by trials interactions. Bonferroni adjustment to alpha level when multiple comparisons to avoid Type II error. Statistical significance, $p = 0.05$.

10. Results	Significant trial effect as each group showed a decrease in dietary chromium intake from pre- to post-test. Resting insulin concentration significantly higher in the chromium group, compared to before chromium supplementation (baseline). However, the change in insulin concentration in the chromium group did not significantly effect fasting serum glucose concentration. No significant differences between or within groups with respect to energy intake, body weight, lean body mass, percentage body fat or fat mass pre- or post-chromium supplementation. No significant changes in muscular performance with exception of a significant increase in upper body endurance in the control and placebo groups from baseline and a significant increase in bench press power from baseline in the placebo group. No significant changes in any physical performance parameter were identified for the chromium group.
11. Conclusion	Based on observation of NCAA varsity wrestlers involved in preseason training, the authors concluded that 14-weeks of chromium picolinate supplementation did not significantly enhance body composition and physical performance variables beyond the improvements experienced with resistance and metabolic training alone.

Appendix A Study Summary

Author: Campbell et al. (1999)
Title: Effects of Resistance Training and Chromium Picolinate on Body Composition and Skeletal Muscle in Older Men

1. Location and Funding	University of Arkansas, Arkansas, USA. (supported by National Institute on Ageing Grants and Nutrition 21, Inc., San Diego, California)
2. Study Objectives	To assess the effect of high-dose chromium picolinate supplementation on body composition, including body density, whole body muscle mass and muscle fibre area, muscle strength and power and resting metabolic rate of older man during 12-weeks of resistance training.
3. Number of Subjects Description	18 Males Older men, aged 56-69 years.
4. Chromium Type and Dosage (Brand)	924 $\mu g \cdot d^{-1}$ Chromium Picolinate (provided by Nutrition 21, Inc., San Diego, California).
5. Exercise Training (frequency)	Resistance (2 $d \cdot wk^{-1}$)
6. Duration of Study	12-Weeks
7. Controlling of Bias	• Subjects assigned to placebo or chromium groups randomly. • Double-blind study design. • Explanation of subject withdrawals. • Chromium intake controlled during assessment period using planned menus. • Chromium supplementation and training monitored. • Jadad 3-item quality assessment score: 4/5
8. Variables Measured & Analytical Technique	• **Body weight** (scale, accurate to ± 0.1 kg) • **Percentage body fat, Fat mass and Fat-free mass** (hydrostatic weighing) • **Total body muscle mass** (urinary creatinine excretion) • **Skinfold thickness** (biceps, triceps, chest, subscapular, mid-axial, abdomen, suprailiac and thigh) • **Type I & II muscle fibre** (muscle biopsy) • **Muscular power** (1RM seated arm-pull and leg-extension) • **Urinary chromium excretion** (atomic absorption spectrophotometry) • **Resting metabolic rate** (Ventilation hood system)
9. Statistical Analysis	The difference between the chromium picolinate and placebo group for each of the independent variables reported were determined using Student's unpaired *t*-test. Main effects of resistance training and chromium picolinate supplementation and interactions among dependent variables on each of the independent variables were determined by using two-way repeated-measures ANOVAs.
10. Results	Chromium supplementation was not associated with any significant changes in body composition. Resistance training was associated with a significant

	increase in body density, due a significant reduction in body fat, fat mass and an increase in fat-free mass. Total body water decreased with resistance training, whilst protein and mineral mass increased, chest circumference also decreased. Where there was no significant change in type I muscle fibre, type II muscle fibre area significantly increased with resistance training. The placebo group gained significantly more strength in both left and right knee-extension exercises compared to the chromium group.
11. Conclusion	Chromium picolinate supplementation has no effect in the augmentation of changes in body composition or muscle size or function when used in combination with a resistance training program by older males.

Appendix A Study Summary

Author: Crawford et al. (1999)
Title: Effect of Niacin-Bound Chromium Supplementation on Body Composition in Overweight African-American Women

1. Location and Funding	Decades Inc. and Georgetown University Medical Center, Washington, District of Columbia, USA. (supported by a grant from InterHealth Nutritionals of Concord, California, USA)
2. Study Objectives	Study was designed to determine whether 600 $\mu g \cdot d^{-1}$ niacin-bound chromium ingested daily over two months by African-American women undergoing a modest dietary and exercise regimen influences weight loss and body composition.
3. Number of Subjects Description	18 Females Overweight (mean 84.7 kg, range 62.3-129 kg), African-American women, who desired to lose weight.
4. Chromium Type and Dosage (Brand)	600 $\mu g \cdot d^{-1}$ Niacin-bound chromium (provided by InterHealth Neutraceutical Inc., Concord, California, USA – product name ChromeMate™)
5. Exercise Training (frequency)	Minimum of 3 $d \cdot wk^{-1}$ Exercise training (supervised, no further details of exercise protocol provided).
6. Duration of Study	2-Months, with 1-month "wash-out" period between treatments.
7. Controlling of Bias	• Subjects randomly assigned to receive either chromium or placebo during first testing period. • Double-blind study design. • Explanation of subject withdrawals provided. • Jadad 3-item quality assessment score: 4/5
8. Variables Measured & Analytical Technique	• **Body weight** (scale) • **Fat mass and Fat-free mass** (Bioelectrical impedance technology) • **25 Blood parameters (metabolites)**
9. Statistical Analysis	Student's *t*-test, paired analysis to assess changes in body composition parameters and blood metabolites. One-way ANOVA to determine significance when comparing mass changes between treatments. Significance level, $p = 0.05$.
10. Results	Group One (placebo/chromium) Significant reduction of fat weight following the chromium supplementation period compared to the placebo. Also chromium supplementation was associated with a significant preservation of lean body mass compared to placebo period. No significant change in body weight or blood parameters with the exception of Gamma glutamyl transferase (GGT) which was significantly lower in the placebo period compared to chromium. Group Two (chromium/placebo) Significant reduction in fat mass following the placebo supplementation period compared to the chromium, no significant change in fat-free mass, body weight or blood parameters with the exception of white blood cell and

	platelet counts which were significantly decreased during the chromium period compared to placebo.
11. Conclusion	Niacin-bound chromium can have favourable results in African-American women who are contemplating loss of fat mass. No evidence of toxicity seen after oral ingestion for two-months of 600 $\mu g \cdot d^{-1}$ chromium in the form of niacin-bound chromium.

Appendix A Study Summary

Author: Amato et al. (2000)
Title: Effects of Chromium Picolinate Supplementation on Insulin Sensitivity, Serum Lipids and Body Composition in Healthy, Non-obese, Older Men and Women.

1. Location and Funding	University of California, San Diego, California, USA. (support in part by General Clinical Research Center Grant).
2. Study Objectives	The purpose of this study was to examine the effect of chromium picolinate on insulin sensitivity, serum lipids and body composition in healthy, non-obese, older men and women.
3. Number of Subjects Description	9 Males, 10 Females Subjects aged 63-77 years, with body-mass index of between 22-28 kg/m^2
4. Chromium Type and Dosage (Brand)	1000 $\mu g \cdot d^{-1}$ Chromium Picolinate (supplied by Nutrition 21, Inc., San Diego, California).
5. Exercise Training (frequency)	Instructed to continue current diet and exercise regimen by a nutritionist. (3-day dietary record completed at beginning and end of study) (no values on energy intake of energy expenditure, although authors indicated that there were no significant changes by individuals during the trial).
6. Duration of Study	8-Weeks
7. Controlling of Bias	• Subjects assigned to placebo or chromium group randomly. • Double-blind study design. • Compliance of chromium supplementation monitored. • Statement indicating no subject withdrawals. • Jadad 3-item quality assessment score: 5/5
8. Variables Measured & Analytical Technique	• **Body weight and BMI** • **Percentage body fat** (Dual X-ray Absorptiometry) • **Insulin sensitivity** (response to intravenous glucose tolerance test) • **Serum total cholesterol, LDL-c, HDL-c, Apolipoproteins A1 and B** • **Serum chromium concentration** (atomic absorption spectrophotometry)
9. Statistical Analysis	Baseline characteristics of the two groups were compared by a group *t*-test (two-tailed). Serum lipids, body composition and insulin sensitivity were analysed by a one-way ANOVA. Significance level, $p = 0.05$.
10. Results	Serum chromium concentrations were elevated from baseline in the chromium group following 8-weeks of chromium supplementation. There were no significant changes in any serum lipid assays, body composition parameters or insulin sensitivity in either the chromium or placebo groups.
11. Conclusion	Chromium picolinate supplementation alone does not appear to improve insulin sensitivity, serum lipids or change body composition in non-obese, healthy men and women of advanced age.

Appendix A Study Summary

Author: Davis et al. (2000)
Title: Effects of Carbohydrate and Chromium Ingestion during Intermittent High-Intensity Exercise to Fatigue.

1. Location and Funding	University of South Carolina, Columbia, South Carolina, USA. (no statement of funding provided)
2. Study Objectives	Purpose of study was to determine the effects of ingestion of carbohydrate drinks, with and without chromium, on fatigue during intermittent, high-intensity, 20-metre shuttle running.
3. Number of Subjects Description	8 Males Active males from University setting, estimated VO_{2max} 55.0 ± 6.7 ml · kg · min^{-1}, mean age 27.1 ± 6.7 years.
4. Chromium Type and Dosage (Brand)	200 μg chromium picolinate one-hour prior to shuttle running and, 200 μg chromium picolinate 10-minutes prior to shuttle
5. Study Design	Repeated measures, each subject completed three trials with placebo, carbohydrate and carbohydrate with chromium, with one week separating trials.
6. Controlling of Bias	• Double-blind study design • Jadad 3-item quality assessment score: 2/5
7. Variables Measured & Analytical Technique	• **Run time to fatigue** • **Heart rate** • **Plasma lactate concentration** • **Plasma glucose concentration** • **Plasma insulin concentration** • **Plasma free-fatty acid concentration**
8. Statistical Analysis	One-way ANOVA procedure was used to detect differences in performance data (run time to fatigue). Blood variables and heart rate were analysed using two-way ANOVA (treatment x trial) with repeated measures. Significance level, $p = 0.05$. Bonferroni adjustment for multiple comparisons.
9. Results	Average run time to fatigue was significantly longer in trials supplemented with carbohydrate. No difference in run time to fatigue between carbohydrate and carbohydrate combined with chromium. Heart rate was significantly lower at all time points in all trials supplemented with carbohydrate compared to placebo. Glucose concentration was significantly higher in the carbohydrate only trial 15-minutes post-ingestion compared to placebo and carbohydrate/chromium trial.
10. Conclusion	Carbohydrate drinks supplemented with chromium throughout intermittent, high-intensity shuttle running does not improve performance beyond that which is provided by carbohydrate supplementation alone.

Appendix A Study Summary

Author: Livolsi et al. (2001)
Title: The Effect of Chromium Picolinate on Muscular Strength and Body Composition in Women Athletes.

1. Location and Funding	California State University-Fullerton, Fullerton, California, USA. (analysis of urine samples funded by Whitaker Wellness, Newport Beach, California, USA).
2. Study Objectives	The purpose of this study was to assess the effects of 500 $\mu g \cdot d^{-1}$ chromium picolinate on muscular strength and body composition in women athletes carrying out resistance training over a 6-week period.
3. Number of Subjects Description	15 Females University division I, softball athletes, aged 17-21 years, body weight 47.8 to 82.5 kg.
4. Chromium Type and Dosage (Brand)	500 $\mu g \cdot d^{-1}$ Chromium Picolinate (brand Nutrition 21, Inc., San Diego, California, USA).
5. Exercise Training (frequency)	Resistance (3 $d \cdot wk^{-1}$)
6. Duration of Study	6-Weeks
7. Controlling of Bias	• Subjects assigned randomly to placebo and chromium groups. • Double-blind study design. • Chromium compliance controlled and training supervised. • Explanation of withdrawals provided. • Jadad 3-item quality assessment score: 4/5
8. Variables Measured & Analytical Technique	• **Body weight** • **Percentage body fat, Lean body mass** (Hydrostatic weighing) • **Urinary chromium excretion** (graphite-furnace atomic spectrophotometry) • **Strength** (1RM – leg press & curl, lat pulldown, incline press and seated 1-arm dumbbell curl) • **Energy & Chromium intake** (3-d dietary records)
9. Statistical Analysis	Statistical analysis of 4, 2-way ANOVAs [supplementation x time], with repeated measures on time factor to examine muscular strength, body weight, percentage body fat and lean body mass, respectively. Non-parametric Wilcoxon signed rank test for comparing related samples was conducted on urinary excretion. Significance level, $p = 0.05$.
10. Results	No significant changes in muscular strength, body weight, percentage body fat, lean body mass in either placebo or chromium groups from baseline. Urinary chromium excretion significantly increased in the chromium group compared to baseline and placebo group.
11. Conclusion	Conclude that chromium picolinate supplementation of 500 $\mu g \cdot d^{-1}$ given to female softball players during preseason training increases chromium urinary excretion, but does not affect strength or body composition when combined with 6-weeks of resistance training.

Appendix A Study Summary

Author: Volpe et al. (2001)
Title: Effect of Chromium Supplementation and Exercise on Body Composition, Resting Metabolic Rate and Selected Biochemical Parameters in Moderately Obese Women Following an Exercise Program

1. Location and Funding	University of Massachusetts, Massachusetts, USA. (funded by Nutrition 21, Inc., San Diego, California, USA).
2. Study Objectives	The purpose of this study was to examine the effects of supplementation with 400 $\mu g \cdot d^{-1}$ chromium picolinate on body composition, resting metabolic rate, plasma glucose, serum insulin, serum C-peptide, plasma glucagon and serum lipid concentration, iron indices and plasma zinc concentration in sedentary, moderately obese women, participating in a 12-week exercise program.
3. Number of Subjects Description	44 Females Obese BMI 27-41 kg/m^2, aged 27-51 years, previously sedentary.
4. Chromium Type and Dosage (Brand)	400 $\mu g \cdot d^{-1}$ Chromium Picolinate (provided by Nutrition 21, Inc., San Diego, California, USA).
5. Exercise Training (frequency)	Resistance and moderate-intense walking (2 $d \cdot wk^{-1}$)
6. Duration of Study	12-Weeks
7. Controlling of Bias	• Subjects assigned to placebo and chromium groups randomly. • Double-blind study design. • Chromium supplementation monitored and training supervised. • Jadad 3-item quality assessment score: 3/5
8. Variables Measured & Analytical Technique	• **Body weight** • **Percentage body fat, Fat mass, Lean body mass** (Hydrostatic weighing) • **Circumference** (waist and hips) • **Resting metabolic rate** (dilution hood) • **Blood glucose, Insulin, Glucagon and C-Peptide** (radioimmunoassay) • **Blood lipid, Iron, Zinc** (spectrophotometer) • **Serum chromium concentration** (Atomic absorption spectrometer - Graphite furnace) • **Urine chromium excretion** (Perkin0Elmer AS-71 autosampler) • **Dietary intake (chromium)** (3-d dietary record)
9. Statistical Analysis	A 2 x 3 factorial ANOVA for treatment (placebo vs. chromium) and time (pre-, mid-, post-test), with repeated measures over time was used to analyse body composition, resting metabolic rate, urinary chromium, iron, creatinine and dietary data. A 2 x 2 factorial ANOVA for treatment (placebo vs. chromium) and time (pre- and post-test) with repeated measures over time was used to analyse serum and plasma biochemical data. Tukey post-hoc test used to identify where significant differences lie in a multiple analysis. Significance level, $p = 0.05$.
10. Results	No significant changes or differences in body composition parameters, body

	weight, resting metabolic rate, biochemical parameters or dietary intake between chromium and placebo groups. Only when chromium and placebo groups combined were significant reductions in percentage body fat, fat mass, total cholesterol and increases in lean body mass and HDL-c found due to exercise training. Urinary chromium excretion was significantly elevated following 6-weeks of chromium supplementation in the chromium group and returned to baseline values at 12-weeks. Serum chromium concentration increased significantly above placebo and baseline values in the chromium group.
11. Conclusion	Conclude that supplementation with 400 $\mu g \cdot d^{-1}$ chromium picolinate, combined with 12-weeks of a moderately-intense weight training and walking program, did not result in significant changes in body composition, resting metabolic rate, glucose tolerance and related hormones, serum lipid concentrations, iron status and zinc status compared to placebo in previously sedentary, moderately obese females. Changes in body composition and select serum lipids were due to exercise training alone. The significant increase in serum and urinary chromium concentration is consistent with the known effects of chromium supplementation. However, the return to baseline value of urinary chromium excretion in the chromium group by week 12 is suggestive of a preservative adaptation to urinary chromium excretion.

Appendix A Study Summary

Author: Campbell et al. (2002)
Title: Effects of Resistance Training and Chromium Picolinate on Body Composition and Skeletal Muscle Size in Older Women

1. Location and Funding	Purdue University, Indiana, USA. (supported by National Institute on Ageing grants and Nutrition 21, Inc., San Diego, California).
2. Study Objectives	The purpose of the present study was to assess the effects of high-dose chromium picolinate supplementation on whole body composition and skeletal muscle strength and size in older women before and after the completion of 12-weeks resistive training program.
3. Number of Subjects Description	17 Females Overweight to moderately obese, aged 54-71 years.
4. Chromium Type and Dosage (Brand)	924 $\mu g \cdot d^{-1}$ Chromium Picolinate (provided by Nutrition 21, Inc., San Diego, California).
5. Exercise Training (frequency)	Resistance ($2\ d \cdot wk^{-1}$)
6. Duration of Study	12-Weeks
7. Controlling of Bias	• Subjects assigned to placebo or chromium groups randomly. • Double-blind study design. • Chromium intake controlled during assessment period using planned menus. • Chromium supplementation and training monitored. • Jadad 3-item quality assessment score: 3/5
8. Variables Measured & Analytical Technique	• **Body weight** (scale, accurate to ± 0.1 kg) • **Percentage body fat, Fat mass and Fat-free mass** (Hydrostatic weighing) • **Skinfold thickness** (biceps, triceps, chest, subscapular, mid-axial, abdomen, suprailiac and thigh) • **Type I & II muscle fibre** (muscle biopsy) • **Maximum muscular strength** (right & left knee extensions, double-leg curl & press, chest press, arm-pull) • **Urinary chromium excretion** (Graphite-furnace atomic absorption spectrophotometer) • **Energy & Chromium Intake** (5-d dietary record).
9. Statistical Analysis	The difference between the chromium picolinate and placebo group for each of the independent variables reported were determined using Student's unpaired *t*-test. Main effects of resistance training and chromium picolinate supplementation and interactions among dependent variables on each of the independent variables were determined by using two-way repeated-measures ANOVAs. Significance level, $p = 0.05$.
10. Results	Chromium supplementation was not associated with an significant change in body composition parameter, maximal strength or skeletal muscle fibre area

	compared to baseline or placebo group. Resistance training significantly all parameters of maximal muscular strength. Chromium supplementation significantly increased urinary chromium excretion compared to baseline and placebo group.
11. Conclusion	The course of 12-weeks progressive weight training in women who consumed high-dose chromium picolinate supplements did not differ from women who consumed a placebo in muscle strength gains, whole body composition and muscle fibre area. This data does not support the use of chromium picolinate by older women to augment the effects of resistive training.

Appendix A Study Summary

Author: Diaz et al. (2007)
Title: Chromium Picolinate and Conjugated Linoleic Acid do not Synergistically Influence Diet- and Exercise-induced changes in Body Composition and Health Indexes in Overweight Women.

1. Location and Funding	Purdue University, Indiana, USA. (supported by Nutrition 21, Inc., Purchase, New York, USA).
2. Study Objectives	The purpose of this research was to assess the effects of a supplement containing chromium picolinate and conjugated linoleic acid on changes in body weight, body composition and indexes of metabolic and cardiovascular health in obese women during a 12-week period of moderate energy restriction and exercise intervention.
3. Number of Subjects Description	35 Females Overweight to moderately obese (BMI 25-34 kg/m^2), aged 21-50 years.
4. Chromium Type and Dosage (Brand)	447 $\mu g \cdot d^{-1}$ Chromium Picolinate combined with 1.92 $g \cdot d^{-1}$ Conjugated Linoleic Acid (provided by Nutrition 21, Inc., Purchase, New York, USA).
5. Exercise Training (frequency)	Moderate intensity jogging, unsupervised, 30min $\cdot d^{-1}$ (5 $d \cdot wk^{-1}$)
6. Duration of Study	12-Weeks
7. Controlling of Bias	• Subjects assigned to placebo or chromium groups randomly • Double-blind study design • Chromium compliance by urine analysis, subjects required to record exercise in a daily log • Explanation of withdrawals provided. • Jadad 3-item quality assessment score: 4/5
8. Variables Measured & Analytical Technique	• **Body weight & BMI** (scale, accurate to ± 0.01 kg) • **Body fat and Fat-free mass** (Dual X-ray Absorptiometry) • **Aerobic fitness** (Treadmill – Stanford 3mph protocol) • **Nutrient & Energy intake (chromium)** (3-d dietary records) • **Urinary chromium excretion** • **Serum haemoglobin A_{1c}, Glucose and Insulin concentration** • **Serum total cholesterol, HDL-c and Triglyceride concentrations** (COBAS analyser)
9. Statistical Analysis	Unpaired *t*-tests were used to assess group differences at baseline. The main effects of time (diet and exercise) and supplementation (CP-CLA vs. placebo) and the time by supplement indicators were assessed by two-factor, repeated-measures ANOVA. Significance level, $p = 0.05$.
10. Results	No significant differences of chromium picolinate and conjugated linoleic acid supplementation to dietary energy and nutrient intake, aerobic fitness, body composition, metabolic or cardiovascular health indices were demonstrated compared to placebo group. Urinary chromium excretion concentration significantly increased, evidence of the effectiveness of the supplement to provide high levels of chromium to the chromium supplemented group.

11. Conclusion	The results of this study support that combined supplementation of chromium picolinate and conjugated linoleic acid for 12-weeks to overweight, but otherwise apparently healthy premenopausal women, in conjunction with moderate calorie restriction and exercise, did not influence losses of body weight and body fat, compared to women who consumed a placebo.

Appendix A Study Summary

Author: Lukaski et al. (2007)
Title: Chromium Picolinate Supplementation in Women: Effect on Body Weight, Composition and Iron Status.

1. Location and Funding	United States Department of Agriculture, Grand Forks, North Dakota, USA. (no statement of funding provided)
2. Study Objectives	This study examined the effects of chromium picolinate supplementation on body weight and composition and on blood biochemical indicators of iron nutritional status in women fed constant energy and nutrient composition diets.
3. Number of Subjects Description	83 Females Premenopausal women, aged 19-50 years, body mass index 18-30 kg/m^2.
4. Chromium Type and Dosage (Brand)	200 μg · d^{-1} Chromium Picolinate, plus a control group which received 1720 μg picolinic acid (provided by Nutrition 21 Inc., Purchase, New York, USA).
5. Exercise Training (frequency)	None described (no exercise record reported)
6. Duration of Study	12-Weeks
7. Controlling of Bias	• Subjects randomly assigned to chromium, placebo or control groups. • Double-blind study design. • Jadad 3-item quality assessment score: 3/5
8. Variables Measured & Analytical Technique	• **Body weight & BMI** (scale, accurate to ± 0.2 kg) • **Fat mass, Fat-free, mineral-free mass, Bone mineral content** (Dual X-ray Absorptiometry) • **Urinary chromium excretion** (graphite-furnace atomic absorption spectrophotometry) • **Skinfold thickness** (biceps, triceps, subscapular and iliac) • **Hematocrit, Haemoglobin, Plasma Iron and Total-iron binding capacity, Transferrin saturation and Serum Chromium concentration**
9. Statistical Analysis	A 3 x 4 repeated measures ANOVA was used to determine the effects of supplementation (placebo, chromium picolinate, picolinic acid) and time (baseline, 4-, 8-, 12-week) on body weight, composition and blood biochemical and urinary indications of iron nutritional status and chromium intake. Tukey's post-hoc test to identify significant differences in main effects. Bonferroni contrasts used when significant interactions found.
10. Results	Chromium supplementation did not effect body weight or composition, iron status, or total-iron binding capacity, transferrin saturation or skinfold thickness compared to placebo or control groups. Urinary chromium excretion and serum chromium concentration were significantly increased compared to placebo, control and baseline. The picolinic acid group (control) experienced a slight, significant increase in serum chromium concentration following 8- and 12-weeks of supplementation.

11. Conclusion	Findings of the present study do not support the hypothesis of an independent effect of chromium, as chromium picolinate, on propitious changes in body composition of women fed the recommended daily intake of chromium in an experimental diet