Supplementary file 2: Extraction form

Document entitled: Fake Anabolic Androgenic Steroids on the Black Market – a systematic review and meta-analysis on qualitative and quantitative analytical results found within the literature

Author/Year/ Country/Ref	Study period	Analytical methods	Sample Information	Classes of compounds/ Sample size Number	Prop. of originals	Prop. of substandards	Prop. of counterfeit	Remarks
Weber C., et. al., 2017, Switzerland [1]	2013-2014	LC-MS/MS, SDS-PAGE coupled with nano LC-HRMS, HCG Immunoassay	Seized by Swiss customs authorities	S1, S2, S4 Total N=1190 S1: N = 889 (75%) S2: N = 146 (12%) S4: N = 113 (9%)	40.6%* (361/889)	49.2% (383/779) Of those: - UC: 91.9% (349/383) - OC: 8.9% (34/383)	59.4% (528/889) Of those: - A: 38.6%* (204/528) - S: 51.9% (274/528) - I: 9.47% (50/528)	Oral formulations more often within the anticipated concentration than parental formulations Defined range of declared label: 50-200% Label information: 204 different manufacturers in 48 different countries origin Possible over- or under estimation of qualitative analysis due to mixed sample (adulterated and original)
Fabresse N., et.al., 2021, France [2]	2016-2019	GC-MS, LC-HRMS, LC-MS/MS	Seized pharmaceuticals by Justice in sport hall	S1, S2, S4, sexual performance enhancers, Dietary supplements Total N=75 S1 N= 54 (72%)	7.41%** (4/54) 20.4%* (11/54)	37.0% (20/54)	40.7% (22/54)	8/54 not quantified, of those 7/54 qualitatively accurately labeled Defined range of declared label 80-130% Other substance classes not further specified
Neves D., et. al. 2013, Brazil [3]	2006-2011	GC-MS, IR/UV spectrophotometry, LC-HRMS	Seized pharmaceuticals by the Brazilian Federal Police department	S1, S2, S3, Total N=3676 S1: N=3636 (98.9%) N=2818/3676 (76.7%) chemically analyzed	58.6%* (1651/2818)		41.4% (1167/2818) Of those: - A: 7.03%* (82/1167) - S: 28.3% (330/1167) - I: 48.6%* (567/1167) - Fake packaging/ manufacturer 16.1% (188/1167)	Mixed sample Other substance classes not further specified Increase by 5.2-fold (1468/ 282) of seizures from 2007-2011 No analysis of concentrations was conducted

Odoardi A., et. al., 2021, Italy [4]	2017-2019	GC-MS, LC-HRMS	Confiscated by police operations performed by Carabinieri in the whole Italian territory	S1, S3, S4, sexual performance enhancers, Stimulants Total N=409 S1: N=267 (65%) S4: N=49 (12%)	74.2%* (198/267)		19.5% (52/267)	Not labelled S1: 6.37% (17/267) Quantitative (N=unknown) determination showed discrepancies between declared and actual content. For AAS, the quantitative content of the single compound was always lower than the one stated on the label
Krug O., et. al., 2014, Germany [5]	2010-2013	LC-HRMS, GC-HRMS, SDS-PAGE coupled with nano LC-HRMS	Confiscated products by the German Bureau of Customs Investigation or purchased on the black market via internet	S1, S2, S4, Others Total N=337 S1: 83.7% S2: 12.8% S4: 3.2%	43%*		57%	Mixed sample No analysis of concentrations was conducted
Neves D., et. al. 2017, Brazil [6]	2011-2016	GC-MS	Seized pharmaceuticals by the Brazilian Federal Police department	S1, Dietary supplements S1: N=328	47.0%** (154/328) 57.9%* (190/328)	11.0% (36/328) Of those: - OC: 58.3% (21/36) - UC: 41.7% (15/36)	42.1% (138/328)* Of those: - A: 1.45% (2/138) - S: 29.7% (41/138) - I: 52.2% (72/138) - Inexistent medication 9.42% (13/138)	Counterfeit: Differences in formulation: 28.7% tablets, 12% suspension, 65% oil-based solutions OC (142% up to 221% of label; most likely fake in oil-based solutions). UC (16.4%-58% of label; most likely fake in oil-based solutions)
Graham M., et. al., 2009, United Kingdom, [7]	2009	GC-MS	Black market	S1, S2, S3, S4, S5 N= 57 (78.9% S1) S1: N= 42	59.5%* (25/42)		42.5% (17/42) Of those: S: 41.2% (7/17) I: 58.8% (10/17) A: 0% (0/17)	No analysis of concentrations was conducted Skin commensals were found as contaminants in injectables (quantity of vials unknown) More counterfeiting in injectables vs. oral formulations
Tircova B., et. al., 2019, Czech Republic/ Slovakia, [8]	2017-2018	LC-MS/MS	Obtained voluntarily from users	S1 N=358	59.2%** (212/358) 79.6%* (285/358)	20.4% (73/358) Of those: - OC: 17.8% (13/73)	20.4% (73/358) Of those: - S: 21.9% (16/73) - I: 78.1% (57/73)	Defined range of declared label 80-120% Differences in formulation:

						- UC: 82.2% (60/73)	- A: n.d.	43% of oil-based substances vs. 37% of tablets and capsules were substandard or counterfeit Label information: 48 different manufacturers, 29 underground labs, 19 pharmaceutical companies
Thevis M. et. al., 2008, Germany, [9]	Un-known	LC-MS/MS, GC-MS	Confiscated products	S1, S4, Stimulants, Sexual performance enhancements N=70 S1: N= 50 (68.6%)	68.0%* (34/50)		32.0% (16/50) S: 62.5% (10/16) A: 37.5% (6/16) I: 0% (0/16)	Visual inspection did not allow a differentiation between original and counterfeit products No analysis of concentrations was conducted
Ribeiro M., et. al., 2018, Brazil, [10]	Un-known	1H NMR, GC-MS	Seized pharmaceuticals by the Brazilian Federal Police department	S1 N=40	22.5%** (9/40) 80%* (32/40)	57.5% (23/40)	20%* (8/40)	Quantitative results (without defined range): substandard mostly under-concentrated
Berneira L., et. al., 2019, Brazil, [11]	2017	GC-MS, FT-IR, DSC	Seized pharmaceuticals by the Brazilian Federal Police department	S1 N=8	75%* (6/8)		25% (2/8)	Visual inspection allied with instrumental characterization of the AAS, were crucial procedures to characterize and detect falsifications Quantitative results (without defined range): substandard all under-concentrated
Coopman V., et. al., 2012, Belgium, [12]	Un-known	LC-UV, GC-MS	Confiscated products from bodybuilders	S1, S3, S4, sexual performance enhancements N=71 S1: N=56 (56.3%)	60.7%* (34/56)*		39.3% (22/56) Of those: - S: 54.5% (12/22) - A: 40.9% (9/22) - I: 4.55% (1/22)	*No analysis of concentrations was conducted, but quantities are described to be lower
Pellegrini M., et. al., 2012, Italy, [13]	Un-known	GC-MS	Seized by Carabinieri	S1 N=15	13.3%** (2/15) 33.3%* (5/15)	20% (3/15)	66.7% (10/15) Of those: - S: 80% (8/10) - I: 20% (2/10) - A: 0% (0/10)	No range of concentrations declared for substandard declared by author

Riberio M., et. al., 2018, Brazil, [14]	Un-known	1H NMR spectroscopic	Commercial samples	S1 N=16	75%* (12/16)		25% (4/16)	For the majority of analyzed drugs the concentration was much smaller than indicated
Campos E., et. al., 2020, Brazil, [15]	Un-known	LC-HRMS	Seized pharmaceuticals by the Brazilian Federal Police department	S1 Only tablet/packs of Stanozolol N=31	9.68%** (3/31)	90.3% (28/31) Of those: - OC: 71.4% (20/28) - UC: 28.6% (8/28)		Stanozolol was tested for quantity only; Defined range of declared label was between 90-110% (Lowest concentration found 9.3% (23.3/250mg) of indicated on label, highest concentration found 225% (22.5mg/10mg).
Musshoff, F. et. al. 1997, Germany [16]	Un-known	GC-MS	Black market	S1 N=37 known AAS	59.5%* (22/37)		40.5% (15/37) Of those: - S: 93.3% (14/15) - A: 0% (0/15) - I: 6.67% (1/15)	No analysis of concentrations was conducted
Lemos, V. F. et. al. 2021, Brazil [17]	Un-known	Attenuated Total Reflection Fourier Transform Infrared Microspectroscopy (μATR-FTIR) mapping	Seized pharmaceuticals by the Brazilian Federal Police department	S1 N=30	70%* (21/30)		30% (9/30) Of those: - S: 33.3% (3/9) - A: 22.2% (2/9) - I: 44.4% (4/9)	Tablets only No analysis of concentrations was conducted
Forsdahl, G. et. al. 2011, Austria [18]	Un-known	GC-MS	Seized pharmaceuticals by the Austrian police	S1 N=28 known testosterone esters	71.4%* (20/28)		28.6% (8/28) Of those: - S: 0% (0/8) - A: 87.5% (7/8) - I: 12.5% (1/8)	Oil-based testosterone esters for injection only No analysis of concentrations was conducted
Kozlik, P. et. al. 2016, Slovakia [19]	Un-known	LC-MS/MS	Blackmarket (online, dealer)	S1 N=9	88.9%* (8/9) 66.7%** (6/9)	22.2% (2/9)	11.1% (1/9)	Oil-based testosterone esters for injection only

*Only accurately labelled/qualitative analysis only
**Accurately labelled and concentration within range/qualitative and quantitative analysis
S = Substituted
A= Adulterated
I = Inert
OC = Overconcentrated
UC = Underconcentrated
n.d = not declared

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