Bibliometric study on Dutch academic medical centers 1998-2014/2015

Research report to the Deans of Medical Sciences (DMW) in the Netherlands

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Contents

1. Introduction

In this report, a bibliometric study is conducted on the research performed within the Dutch academic medical centers. The study consists of two separate parts, of which the first part is presented in this report. The current part of the study is based on a comparison on the output in journals covered by Thomson Scientific in their Web of Science (WoS), on the overall level of academic medical centers in the Netherlands. The second part of the study consists of a lower-level analysis of the organizational structure within each medical center. The findings from that part of the study will be reported confidentially to each medical center separately.

The present report relates to the publication output of the academic medical centers at Dutch universities. The medical centers supplied publication lists to CWTS, which were matched with the CWTS in-house bibliometric data-system. The bibliometric analysis is covering the period 1998-2014/2015 for all eight academic medical centers. This study is an update of the study conducted in 2014/2015, for the update CWTS was supplied with the year 2014 as an additional year to the data collected for the previous studies.
We considered only papers classified in the WoS as normal articles, letters and reviews, published in source serials processed for the WoS database. Please note that in the indicator set of CWTS (see below), letters are weighted with 0.25. Other document types, such as meeting abstracts, 'editorials', 'editorial material', corrections, comments, and book reviews were not included. Also, papers in non-WoS source journals are not counted. A few journals are only partially processed for the WoS. Here, only papers processed for the WoS were included.

Overview of bibliometric indicators

P	Number of papers (normal articles, letters, and reviews) published in journals processed for the Web of Science (WoS).
TCS	Number of citations recorded in WoS journals to all papers involved. Self-citations are excluded.
MCS	Average number of citations per publication, or citation per publication ratio. Self-citations are excluded.
MNCS	The impact of a research unit's articles, compared to the world citation average in the subfields in which the research unit is active.
MNJS	The impact of the journals in which a research unit has published (the research unit's journal selection), compared to the world citation average in the subfields covered by these journals.
MNCS/MNJS	The impact of a research unit's articles, compared to the average citation rate of the research unit's journals (not printed in the data-tables).
PP(uncited)	Percentage of articles not cited during the time period considered.
%Self Cit	Percentage of self-citations. A self-citation is defined as a citation in which the citing and the cited paper have at least one author in common (first author or co-author).
PP(top 10%)	The share of the number of papers that are among the 10% most frequently cited of all similar papers in the period 1998-2014/2015.
Int Cov	This indicates the degree to which a unit refers themselves to the literature covered in the WoS. The reference behavior of a unit thus indicates whether the journal literature is important for the scholarly communication in a field, and as such can be interpreted as indicator of the applicability of bibliometrics in an assessment context.

2. Results

2.1 General results of bibliometric analysis

In **Table 1a** and **1b**, the overall bibliometric scores for the eight academic medical centers in the Netherlands are shown for the periods 1998-2014/2015 and 2010-2014/2015, respectively. **Table 2** contains the trend data for every single medical center in the period 1998-2014/2015. **Table 3** contains likewise results, limited to papers with first authorships of the respective medical center. **Table 4** contains overall and trend data for the eight academic medical centers combined, as a cluster of Dutch academic (bio)medical research.

For an explanation on the methodological aspects of citation impact measurement, we refer to Appendix A, paragraph 1.3.

Table 1a: Bibliometric statistics of Dutch academic medical centers, 1998-2014/2015

	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
Erasmus MC	32338,25	1052533,00	32,55	1,65	1,42	18%	5%	16%	89%
LU MC	23572,25	724565,00	30,74	1,52	1,38	17%	5%	17%	92%
Radboud UMC	24826,75	655694,75	26,41	1,47	1,33	16%	5%	17%	90%
UMC Maastricht	22548,50	662294,75	29,37	1,54	1,28	16%	5%	15%	87%
UMCG	21833,25	534729,75	24,49	1,44	1,36	16%	6%	17%	90%
UU UMC	24724,50	765568,25	30,96	1,59	1,43	18%	5%	15%	91%
UvA AMC	31335,00	868131,25	27,70	1,51	1,36	17%	6%	16%	90%
VUmc	22405,75	689691,25	30,78	1,66	1,36	19%	6%	16%	89%

Table 1b: Bibliometric statistics of Dutch academic medical centers, 2010-2014/2015

	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
Erasmus MC	12491,50	185253,50	14,83	1,78	1,54	20%	9%	22%	90%
LU MC	8991,00	136921,75	15,23	1,66	1,50	19%	8%	22%	92%
Radboud UMC	10092,50	136411,00	13,52	1,66	1,46	19%	9%	22%	90%
UMC Maastricht	8754,00	112017,00	12,80	1,59	1,36	17%	11%	21%	88%
UMCG	9921,50	129897,75	13,09	1,60	1,50	18%	11%	22%	90%
UU UMC	10094,25	147344,50	14,60	1,69	1,55	20%	8%	21%	92%
UvA AMC	13371,25	181873,50	13,60	1,63	1,46	18%	10%	20%	90%
VUmc	10271,50	149090,75	14,51	1,73	1,42	19%	10%	21%	89%

Table 2: Bibliometric statistics of Dutch academic medical centers, trend analysis, 1998-2014/2015

Erasmus MC

	Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
Erasmus MC	1998- 2001	5189,75	47615,75	9,17	1,55	1,33	16%	18%	21%	88%
Erasmus MC	1999- 2002	5325,75	48292,75	9,07	1,49	1,32	16%	18%	21%	89%
Erasmus MC	2000- 2003	5502,00	53952,75	9,81	1,59	1,35	17%	16%	20%	89%
Erasmus MC	2001- 2004	5866,25	59027,50	10,06	1,57	1,34	17%	16%	20%	90%
Erasmus MC	2002- 2005	6455,00	68952,50	10,68	1,57	1,33	17%	14%	20%	89%
Erasmus MC	2003- 2006	7014,75	77226,75	11,01	1,56	1,35	17%	14%	20%	90%
Erasmus MC	2004- 2007	7515,00	82448,50	10,97	1,54	1,35	17%	12%	20%	90%
Erasmus MC	2005- 2008	7880,00	87380,25	11,09	1,55	1,38	17%	12%	20%	90%
Erasmus MC	2006- 2009	8202,00	92830,50	11,32	1,63	1,43	18%	12%	20%	90%
Erasmus MC	2007- 2010	8455,50	99112,75	11,72	1,71	1,48	20%	10%	21%	90%
Erasmus MC	2008- 2011	8749,25	109656,25	12,53	1,72	1,50	20%	10%	21%	90%
Erasmus MC	2009- 2012	9324,00	119809,50	12,85	1,79	1,55	20%	10%	21%	90%
Erasmus MC	2010- 2013	9770,75	121648,25	12,45	1,76	1,55	20%	10%	22%	90%
Erasmus MC	2011- 2014	10261,50	123154,50	12,00	1,76	1,53	20%	10%	22%	90%

LU MC

	Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
LU MC	1998- 2001	4261,00	38541,25	9,05	1,45	1,29	16%	17%	21%	91%
LU MC	1999- 2002	4210,25	37672,25	8,95	1,40	1,29	15%	16%	20%	91%
LU MC	2000- 2003	4212,25	37959,25	9,01	1,33	1,29	14%	15%	20%	92%
LU MC	2001- 2004	4333,25	39739,25	9,17	1,35	1,29	15%	14%	21%	92%
LU MC	2002- 2005	4532,50	41650,75	9,19	1,35	1,29	15%	13%	21%	92%
LU MC	2003- 2006	4861,00	46024,25	9,47	1,36	1,29	15%	13%	21%	92%
LU MC	2004- 2007	5215,75	54565,00	10,46	1,44	1,32	16%	12%	20%	92%
LU MC	2005- 2008	5538,00	58801,50	10,62	1,50	1,35	17%	11%	21%	92%
LU MC	2006- 2009	5787,75	64600,25	11,16	1,52	1,41	17%	11%	21%	92%
LU MC	2007- 2010	6175,00	73168,00	11,85	1,65	1,47	18%	10%	21%	93%
LU MC	2008- 2011	6484,00	78603,75	12,12	1,66	1,49	19%	10%	22%	92%
LU MC	2009- 2012	6854,50	85017,00	12,40	1,64	1,50	19%	10%	23%	92%
LU MC	2010- 2013	7186,25	92859,00	12,92	1,66	1,50	19%	10%	23%	92%
LU MC	2011- 2014	7234,75	85251,25	11,78	1,61	1,50	19%	10%	24%	92%

Radboud UMC

	Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
Radboud UMC	1998- 2001	3891,00	27593,25	7,09	1,31	1,19	14%	20%	22%	87%
Radboud UMC	1999- 2002	3945,50	28491,00	7,22	1,30	1,21	14%	19%	23%	88%
Radboud UMC	2000- 2003	4246,00	31638,50	7,45	1,28	1,20	14%	18%	22%	89%
Radboud UMC	2001- 2004	4466,75	34535,00	7,73	1,26	1,19	14%	18%	22%	89%
Radboud UMC	2002- 2005	4900,50	39319,25	8,02	1,24	1,21	13%	15%	21%	89%
Radboud UMC	2003- 2006	5338,50	42895,75	8,04	1,26	1,21	13%	15%	21%	89%
Radboud UMC	2004- 2007	5464,25	47203,50	8,64	1,32	1,25	14%	13%	21%	89%
Radboud UMC	2005- 2008	5744,25	53678,50	9,34	1,40	1,30	15%	13%	20%	90%
Radboud UMC	2006- 2009	5942,75	59493,25	10,01	1,50	1,35	16%	12%	20%	90%
Radboud UMC	2007- 2010	6151,00	66384,00	10,79	1,61	1,42	17%	12%	20%	90%
Radboud UMC	2008- 2011	6721,25	74844,50	11,14	1,59	1,45	18%	12%	21%	90%
Radboud UMC	2009- 2012	7224,50	81542,25	11,29	1,62	1,47	19%	11%	21%	91%
Radboud UMC	2010- 2013	7869,00	88871,25	11,29	1,64	1,47	19%	11%	22%	90%
Radboud UMC	2011- 2014	8386,25	92378,50	11,02	1,65	1,46	18%	11%	22%	90%

UMC Maastricht

	Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
UMC Maastricht	1998- 2001	3633,50	26525,25	7,30	1,48	1,17	14%	23%	21%	84%
UMC Maastricht	1999- 2002	3950,25	30913,50	7,83	1,43	1,18	14%	22%	21%	85%
UMC Maastricht	2000- 2003	4254,00	36758,75	8,64	1,46	1,22	15%	19%	20%	85%
UMC Maastricht	2001- 2004	4514,75	34897,50	7,73	1,35	1,20	15%	18%	21%	86%
UMC Maastricht	2002- 2005	4775,50	38248,25	8,01	1,33	1,18	14%	16%	21%	86%
UMC Maastricht	2003- 2006	5056,50	43555,50	8,61	1,38	1,21	15%	15%	21%	87%
UMC Maastricht	2004- 2007	5230,50	46695,75	8,93	1,41	1,23	15%	13%	21%	87%
UMC Maastricht	2005- 2008	5248,25	49203,25	9,38	1,42	1,25	15%	13%	21%	87%
UMC Maastricht	2006- 2009	5385,50	51880,75	9,63	1,48	1,31	16%	12%	21%	88%
UMC Maastricht	2007- 2010	5502,25	53604,50	9,74	1,54	1,35	17%	11%	21%	88%
UMC Maastricht	2008- 2011	5894,25	57420,00	9,74	1,56	1,36	17%	13%	22%	88%
UMC Maastricht	2009- 2012	6411,00	69279,00	10,81	1,63	1,39	18%	12%	22%	88%
UMC Maastricht	2010- 2013	6789,25	73579,25	10,84	1,60	1,38	18%	11%	22%	88%
UMC Maastricht	2011- 2014	7268,75	74866,00	10,30	1,54	1,35	17%	12%	23%	88%

UMCG

	Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
UMCG	1998- 2001	2729,75	17905,75	6,56	1,27	1,22	13%	22%	23%	88%
UMCG	1999- 2002	2853,25	20619,25	7,23	1,28	1,22	13%	20%	21%	89%
UMCG	2000- 2003	3041,50	22220,25	7,31	1,27	1,21	13%	20%	20%	89%
UMCG	2001- 2004	3293,00	26082,00	7,92	1,32	1,22	14%	20%	20%	89%
UMCG	2002- 2005	3695,00	28599,25	7,74	1,28	1,20	13%	19%	20%	89%
UMCG	2003- 2006	4199,50	33159,25	7,90	1,24	1,21	13%	17%	21%	89%
UMCG	2004- 2007	4578,00	38260,75	8,36	1,26	1,22	13%	16%	20%	89%
UMCG	2005- 2008	5014,00	41353,50	8,25	1,25	1,26	13%	15%	20%	90%
UMCG	2006- 2009	5487,00	46219,50	8,42	1,33	1,31	14%	14%	21%	90%
UMCG	2007- 2010	5939,50	53987,50	9,09	1,47	1,39	16%	12%	21%	90%
UMCG	2008- 2011	6460,75	64871,75	10,04	1,53	1,44	17%	12%	21%	90%
UMCG	2009- 2012	7086,25	76800,25	10,84	1,58	1,48	18%	12%	21%	90%
UMCG	2010- 2013	7655,00	84831,25	11,08	1,59	1,50	18%	12%	22%	90%
UMCG	2011- 2014	8236,00	87283,00	10,60	1,58	1,49	18%	12%	23%	90%

UU UMC

	Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
UU UMC	1998- 2001	3982,00	36386,25	9,14	1,52	1,34	17%	18%	19%	89%
UU UMC	1999- 2002	4203,00	38735,50	9,22	1,53	1,35	16%	17%	19%	90%
UU UMC	2000- 2003	4362,25	41803,25	9,58	1,51	1,34	16%	16%	19%	90%
UU UMC	2001- 2004	4495,25	45992,00	10,23	1,53	1,33	16%	15%	18%	90%
UU UMC	2002- 2005	4750,75	49870,75	10,50	1,48	1,32	16%	14%	17%	91%
UU UMC	2003- 2006	5111,25	49049,75	9,60	1,40	1,30	15%	14%	18%	91%
UU UMC	2004- 2007	5315,75	52629,25	9,90	1,43	1,33	16%	12%	19%	91%
UU UMC	2005- 2008	5578,00	58303,75	10,45	1,52	1,38	17%	11%	19%	91%
UU UMC	2006- 2009	5897,50	63310,50	10,74	1,56	1,44	17%	11%	19%	91%
UU UMC	2007- 2010	6159,25	69142,25	11,23	1,65	1,50	18%	10%	19%	91%
UU UMC	2008- 2011	6673,75	78051,25	11,70	1,68	1,53	19%	9%	20%	92%
UU UMC	2009- 2012	7391,25	87428,75	11,83	1,70	1,54	20%	9%	21%	92%
UU UMC	2010- 2013	7942,50	97117,00	12,23	1,70	1,54	20%	10%	21%	92%
UU UMC	2011- 2014	8369,00	102819,50	12,29	1,69	1,55	20%	10%	22%	92%

UvA AMC

	Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
UvA AMC	1998- 2001	4726,50	38973,50	8,25	1,43	1,27	15%	18%	21%	89%
UvA AMC	1999- 2002	4841,00	41640,50	8,60	1,43	1,26	15%	17%	20%	89%
UvA AMC	2000- 2003	5074,50	42646,75	8,40	1,40	1,25	15%	16%	21%	90%
UvA AMC	2001- 2004	5337,25	47898,75	8,97	1,42	1,26	16%	16%	20%	90%
UvA AMC	2002- 2005	5665,75	53559,75	9,45	1,40	1,25	15%	15%	20%	90%
UvA AMC	2003- 2006	6164,75	59497,75	9,65	1,39	1,26	15%	15%	20%	90%
UvA AMC	2004- 2007	6567,25	62757,00	9,56	1,41	1,30	16%	14%	20%	90%
UvA AMC	2005- 2008	7011,00	68358,50	9,75	1,46	1,33	15%	14%	20%	90%
UvA AMC	2006- 2009	7571,50	75943,00	10,03	1,48	1,36	16%	13%	20%	90%
UvA AMC	2007- 2010	8102,25	85135,00	10,51	1,57	1,41	17%	13%	20%	90%
UvA AMC	2008- 2011	8853,00	94004,25	10,62	1,56	1,41	17%	13%	21%	90%
UvA AMC	2009- 2012	9755,25	104558,75	10,72	1,59	1,43	17%	12%	21%	90%
UvA AMC	2010- 2013	10500,50	119675,00	11,40	1,63	1,46	18%	12%	21%	90%
UvA AMC	2011- 2014	11049,25	123348,00	11,16	1,61	1,46	18%	11%	22%	90%

VUmc

	Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
VUmc	1998- 2001	3299,00	27721,25	8,40	1,51	1,25	16%	17%	22%	88%
VUmc	1999- 2002	3415,50	29897,25	8,75	1,52	1,26	17%	16%	21%	89%
VUmc	2000- 2003	3553,50	30514,25	8,59	1,47	1,25	17%	15%	21%	89%
VUmc	2001- 2004	3721,50	34203,00	9,19	1,48	1,25	16%	15%	21%	90%
VUmc	2002- 2005	4096,75	40320,00	9,84	1,47	1,24	16%	14%	20%	90%
VUmc	2003- 2006	4353,00	44790,25	10,29	1,51	1,26	17%	13%	19%	90%
VUmc	2004- 2007	4535,25	48805,75	10,76	1,52	1,30	17%	12%	19%	89%
VUmc	2005- 2008	4679,75	50983,00	10,89	1,53	1,33	17%	11%	19%	89%
VUmc	2006- 2009	4738,50	52578,00	11,10	1,60	1,39	19%	11%	20%	90%
VUmc	2007- 2010	5208,25	57452,00	11,03	1,74	1,44	20%	11%	20%	89%
VUmc	2008- 2011	6075,25	67538,25	11,12	1,73	1,45	20%	12%	21%	89%
VUmc	2009- 2012	6926,50	82121,75	11,86	1,75	1,45	20%	11%	21%	89%
VUmc	2010- 2013	7905,25	98203,00	12,42	1,76	1,44	20%	11%	22%	89%
VUmc	2011- 2014	8637,50	99680,75	11,54	1,67	1,41	19%	12%	23%	89%

Table 3: Bibliometric statistics of Dutch academic medical centers, first authorships only, 1998-2014/2015

Erasmus MC

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	18453,50	508440,25	27,55	1,40	1,32	16%	5%	15%	90%
2010- 2014	6715,75	78479,50	11,69	1,46	1,39	17%	9%	20%	90%
1998- 2001	3215,25	23859,25	7,42	1,32	1,28	14%	19%	21%	88%
1999- 2002	3298,50	25543,75	7,74	1,31	1,27	14%	18%	21%	89%
2000- 2003	3337,50	27162,50	8,14	1,36	1,29	15%	16%	20%	89%
2001- 2004	3514,75	30024,50	8,54	1,38	1,27	15%	17%	20%	90%
2002- 2005	3805,00	33926,75	8,92	1,39	1,26	15%	14%	20%	90%
2003- 2006	4069,75	38809,75	9,54	1,42	1,28	15%	14%	19%	90%
2004- 2007	4353,00	41791,75	9,60	1,39	1,28	15%	13%	19%	90%
2005- 2008	4539,25	42851,75	9,44	1,38	1,31	15%	13%	20%	90%
2006- 2009	4717,50	45107,50	9,56	1,45	1,35	16%	13%	20%	90%
2007- 2010	4812,00	47704,00	9,91	1,49	1,37	17%	11%	20%	90%
2008- 2011	4963,75	51543,25	10,38	1,48	1,39	17%	11%	20%	90%
2009- 2012	5147,00	53628,00	10,42	1,52	1,40	17%	11%	20%	90%
2010- 2013	5358,75	52533,75	9,80	1,49	1,39	17%	11%	21%	90%
2011- 2014	5494,00	52472,25	9,55	1,44	1,38	17%	11%	21%	90%

LU MC

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	12232,50	322576,50	26,37	1,27	1,26	14%	5%	16%	93%
2010- 2014	4428,75	51473,25	11,62	1,30	1,33	15%	9%	20%	93%
1998- 2001	2360,75	17774,25	7,53	1,22	1,23	13%	19%	20%	91%
1999- 2002	2273,25	17163,75	7,55	1,22	1,22	13%	17%	19%	92%
2000- 2003	2236,75	17548,75	7,85	1,18	1,23	13%	16%	20%	92%
2001- 2004	2276,00	18760,50	8,24	1,22	1,23	14%	15%	20%	93%
2002- 2005	2384,75	19356,25	8,12	1,23	1,24	14%	14%	20%	93%
2003- 2006	2529,00	21459,00	8,49	1,24	1,23	13%	14%	20%	93%
2004- 2007	2780,25	25752,00	9,26	1,32	1,25	14%	13%	20%	93%
2005- 2008	2969,00	28116,75	9,47	1,33	1,27	14%	12%	20%	93%
2006- 2009	3058,25	29329,75	9,59	1,32	1,29	14%	12%	20%	93%
2007- 2010	3280,00	32969,75	10,05	1,37	1,32	15%	11%	19%	93%
2008- 2011	3349,00	32486,50	9,70	1,36	1,34	15%	11%	20%	93%
2009- 2012	3449,50	34155,75	9,90	1,33	1,34	15%	11%	20%	93%
2010- 2013	3567,25	35313,00	9,90	1,31	1,34	15%	10%	20%	93%
2011- 2014	3518,50	32985,75	9,37	1,28	1,33	15%	10%	20%	93%

Radboud UMC

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	13282,25	295641,75	22,26	1,24	1,24	14%	6%	15%	90%
2010- 2014	4976,75	55220,75	11,10	1,40	1,35	16%	11%	19%	91%
1998- 2001	2369,50	13415,25	5,66	1,08	1,11	11%	21%	23%	88%
1999- 2002	2302,50	13439,50	5,84	1,10	1,12	11%	20%	23%	89%
2000- 2003	2427,50	15041,00	6,20	1,13	1,12	12%	20%	22%	89%
2001- 2004	2471,50	15250,50	6,17	1,11	1,12	12%	20%	22%	90%
2002- 2005	2635,75	17764,25	6,74	1,13	1,15	12%	16%	21%	90%
2003- 2006	2848,50	19737,50	6,93	1,13	1,16	12%	17%	21%	90%
2004- 2007	2938,25	21623,75	7,36	1,18	1,19	12%	15%	20%	90%
2005- 2008	3125,25	24285,00	7,77	1,21	1,22	13%	14%	20%	90%
2006- 2009	3300,25	26343,00	7,98	1,29	1,26	14%	13%	19%	90%
2007- 2010	3405,50	29265,75	8,59	1,36	1,29	15%	12%	19%	91%
2008- 2011	3613,25	32693,00	9,05	1,36	1,35	15%	12%	20%	91%
2009- 2012	3781,25	34904,50	9,23	1,38	1,37	16%	12%	19%	91%
2010- 2013	3952,50	36427,50	9,22	1,39	1,36	16%	12%	19%	91%
2011- 2014	4077,75	37930,75	9,30	1,41	1,36	16%	12%	19%	91%

UMC Maastricht

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	11387,25	269421,00	23,66	1,27	1,20	14%	5%	15%	87%
2010- 2014	4009,00	41281,50	10,30	1,35	1,26	16%	11%	19%	88%
1998- 2001	2054,25	10292,75	5,01	1,07	1,11	11%	24%	24%	84%
1999- 2002	2128,25	11001,75	5,17	1,07	1,12	11%	24%	25%	84%
2000- 2003	2234,25	12680,00	5,68	1,11	1,13	11%	21%	24%	85%
2001- 2004	2323,50	13105,25	5,64	1,08	1,12	11%	20%	23%	85%
2002- 2005	2443,00	15331,50	6,28	1,14	1,12	12%	16%	22%	86%
2003- 2006	2546,50	17173,25	6,74	1,16	1,15	12%	16%	22%	86%
2004- 2007	2682,75	18995,50	7,08	1,21	1,17	13%	14%	21%	87%
2005- 2008	2772,50	21315,50	7,69	1,24	1,18	13%	14%	21%	87%
2006- 2009	2881,00	21875,50	7,59	1,25	1,23	13%	14%	21%	88%
2007- 2010	2926,75	23436,00	8,01	1,30	1,25	14%	13%	21%	88%
2008- 2011	2978,25	24828,00	8,34	1,33	1,28	15%	13%	21%	88%
2009- 2012	3094,50	27217,75	8,80	1,38	1,29	16%	12%	21%	89%
2010- 2013	3179,75	27274,25	8,58	1,38	1,29	16%	12%	20%	89%
2011- 2014	3281,75	27712,50	8,44	1,32	1,26	16%	13%	20%	88%

UMCG

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	11827,75	234915,75	19,86	1,14	1,22	12%	7%	15%	90%
2010- 2014	4719,50	45328,00	9,60	1,22	1,31	14%	12%	19%	91%
1998- 2001	1767,25	8959,75	5,07	0,99	1,13	10%	25%	24%	88%
1999- 2002	1825,25	10007,00	5,48	1,00	1,12	9%	22%	21%	89%
2000- 2003	1860,50	10401,75	5,59	1,01	1,12	9%	21%	21%	89%
2001- 2004	1964,50	11295,50	5,75	1,07	1,14	10%	21%	20%	90%
2002- 2005	2185,50	13056,25	5,97	1,04	1,12	10%	20%	20%	90%
2003- 2006	2444,00	14620,75	5,98	1,03	1,14	10%	18%	20%	90%
2004- 2007	2698,75	17720,00	6,57	1,06	1,15	10%	17%	20%	90%
2005- 2008	2938,25	19027,75	6,48	1,04	1,17	10%	16%	20%	90%
2006- 2009	3155,50	21757,50	6,90	1,12	1,21	11%	15%	20%	90%
2007- 2010	3315,50	23997,75	7,24	1,19	1,25	12%	13%	20%	91%
2008- 2011	3479,25	26863,25	7,72	1,21	1,27	13%	13%	20%	91%
2009- 2012	3597,75	30138,00	8,38	1,23	1,30	14%	13%	19%	91%
2010- 2013	3693,50	30076,25	8,14	1,23	1,32	13%	14%	19%	91%
2011- 2014	3847,50	29589,25	7,69	1,21	1,31	13%	13%	20%	91%

UU UMC

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	13643,50	339100,75	24,85	1,31	1,31	15%	5%	14%	92%
2010- 2014	5333,75	59252,25	11,11	1,39	1,37	16%	10%	19%	92%
1998- 2001	2331,00	16628,00	7,13	1,27	1,24	15%	20%	19%	90%
1999- 2002	2445,00	17974,50	7,35	1,26	1,26	14%	19%	19%	90%
2000- 2003	2528,25	19049,25	7,53	1,22	1,24	13%	18%	19%	91%
2001- 2004	2582,25	20006,00	7,75	1,24	1,24	13%	16%	19%	91%
2002- 2005	2671,00	21764,25	8,15	1,22	1,26	13%	15%	18%	92%
2003- 2006	2843,25	22116,00	7,78	1,18	1,26	12%	15%	18%	91%
2004- 2007	2948,00	24246,25	8,22	1,23	1,29	13%	14%	18%	91%
2005- 2008	3142,00	26294,50	8,37	1,28	1,33	14%	12%	18%	91%
2006- 2009	3307,75	28446,75	8,60	1,32	1,35	15%	12%	18%	92%
2007- 2010	3418,00	30990,75	9,07	1,37	1,37	16%	11%	18%	92%
2008- 2011	3634,25	33861,75	9,32	1,38	1,37	16%	11%	19%	92%
2009- 2012	3910,50	36372,75	9,30	1,42	1,38	16%	10%	19%	93%
2010- 2013	4232,00	38885,75	9,19	1,41	1,37	16%	11%	19%	92%
2011- 2014	4419,50	41529,25	9,40	1,39	1,38	16%	12%	19%	92%

UvA AMC

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	13835,75	336640,75	24,33	1,30	1,27	14%	7%	15%	91%
2010- 2014	5562,25	61695,75	11,09	1,37	1,34	15%	11%	18%	91%
1998- 2001	2421,75	16534,00	6,83	1,24	1,19	13%	19%	20%	89%
1999- 2002	2379,00	17835,50	7,50	1,26	1,19	14%	19%	19%	90%
2000- 2003	2368,50	18092,75	7,64	1,26	1,20	14%	18%	19%	90%
2001- 2004	2432,00	19379,75	7,97	1,28	1,21	15%	18%	19%	90%
2002- 2005	2519,50	20748,50	8,24	1,25	1,20	14%	18%	19%	90%
2003- 2006	2718,00	23052,75	8,48	1,22	1,21	13%	16%	19%	91%
2004- 2007	2880,00	24414,50	8,48	1,25	1,25	14%	14%	20%	91%
2005- 2008	3104,50	25400,00	8,18	1,28	1,28	13%	15%	20%	91%
2006- 2009	3332,25	28018,00	8,41	1,27	1,29	13%	14%	19%	91%
2007- 2010	3565,00	30956,00	8,68	1,33	1,33	15%	14%	19%	91%
2008- 2011	3855,75	33729,75	8,75	1,33	1,31	15%	14%	20%	91%
2009- 2012	4098,75	37086,50	9,05	1,38	1,33	15%	13%	20%	91%
2010- 2013	4318,25	41061,00	9,51	1,40	1,34	15%	13%	19%	91%
2011- 2014	4552,75	41471,75	9,11	1,36	1,33	15%	13%	19%	91%

VUmc

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	10931,00	300243,25	27,47	1,44	1,23	16%	6%	15%	89%
2010- 2014	4355,25	49400,25	11,34	1,44	1,29	17%	12%	20%	89%
1998- 2001	1851,50	13733,00	7,42	1,39	1,17	15%	19%	20%	88%
1999- 2002	1927,25	14919,00	7,74	1,37	1,18	15%	17%	20%	89%
2000- 2003	1981,75	14643,50	7,39	1,34	1,18	15%	16%	21%	89%
2001- 2004	2060,75	15842,25	7,69	1,29	1,17	14%	16%	21%	90%
2002- 2005	2244,50	18325,00	8,16	1,30	1,16	14%	15%	21%	90%
2003- 2006	2321,75	20433,00	8,80	1,34	1,17	15%	14%	19%	90%
2004- 2007	2390,75	21948,00	9,18	1,36	1,19	15%	13%	19%	90%
2005- 2008	2471,75	23406,00	9,47	1,38	1,22	15%	13%	19%	90%
2006- 2009	2479,75	23411,25	9,44	1,43	1,25	16%	12%	19%	90%
2007- 2010	2645,25	24849,75	9,39	1,47	1,29	16%	11%	19%	90%
2008- 2011	2888,00	26774,75	9,27	1,45	1,29	17%	13%	20%	90%
2009- 2012	3086,75	29532,50	9,57	1,47	1,30	18%	13%	20%	89%
2010- 2013	3353,25	32451,25	9,68	1,44	1,29	17%	13%	21%	89%
2011- 2014	3600,75	32856,00	9,12	1,40	1,28	16%	13%	21%	89%

Table 4: Bibliometric statistics of all Dutch academic medical centers combined, 1998-2014/2015

Period	P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
1998- 2014	167211,25	4788354,25	28,64	1,51	1,33	17%	5%	16%	90%
2010- 2014	67333,50	905851,50	13,45	1,62	1,43	18%	10%	21%	90%
1998- 2001	27001,75	213124,25	7,89	1,40	1,24	15%	19%	21%	88%
1999- 2002	27672,25	226925,50	8,20	1,40	1,24	15%	19%	21%	89%
2000- 2003	28723,25	245480,50	8,55	1,41	1,25	15%	17%	20%	89%
2001- 2004	29966,75	261745,00	8,73	1,39	1,24	15%	17%	20%	89%
2002- 2005	32130,25	293020,00	9,12	1,39	1,24	15%	15%	20%	90%
2003- 2006	34674,50	322268,25	9,29	1,39	1,25	15%	15%	20%	90%
2004- 2007	36688,25	351485,25	9,58	1,41	1,27	15%	13%	20%	90%
2005- 2008	38738,75	381729,75	9,85	1,44	1,31	16%	13%	20%	90%
2006- 2009	40745,75	408730,50	10,03	1,48	1,34	16%	12%	20%	90%
2007- 2010	42776,25	445552,00	10,42	1,56	1,39	17%	12%	20%	90%
2008- 2011	45742,50	492285,25	10,76	1,58	1,41	18%	12%	21%	90%
2009- 2012	49349,75	550212,25	11,15	1,62	1,43	18%	11%	21%	90%
2010- 2013	52678,25	597746,75	11,35	1,63	1,44	18%	11%	21%	90%
2011- 2014	55552,75	608374,25	10,95	1,60	1,43	18%	11%	21%	90%

2.2 Research profiles

In the research profiles for the eight medical centers, displayed in **Figures 1 to 8** (with a) and b) figures describing the period 1998-2014/2015 and 2010-2014/2015 respectively), the output per academic medical center is displayed to the 1% level of the output (fields with smaller shares than 1% are not displayed). Per medical center, the total share displayed in the profile with respect to the total output is indicated. We have produced the profiles for the full period covered (now 1998 to 2014/2015), and the last five year period 2010-2014/2015. This five year period is already shown in the tables, and is now also introduced in the profiles, as it shows the most recent situation of the performance per UMC.

While reading and using the profiles, it is important to keep in mind that these profiles display information of the output and impact per UMC across fields, particularly focused on the comparison between UMCS. These profiles **do not** provide information on the level of organizational units within every single UMC, as there exists in this analysis no organic link between the units producing papers, and the fields these papers belong to. For that particular information, every UMC has its own internal analysis. So the output and impact in for example *Immunology* can be compared between UMCS, but does not allow any kind of conclusion of the level of units involved in immunological research within every UMC.
In general, around 80% of the output of the medical centers is displayed in the research profiles.

In **Figure 9a**, the research profile covering the period 1998 to 2014/2015 is shown for the combined output of academic medical centers, while **Figure 9b** shows the situation for the period 2010-2014/2015 for the combined output of academic medical centers is displayed.

Figure 1a: Output and normalized impact per field (1998-2014/2015)
Erasmus MC

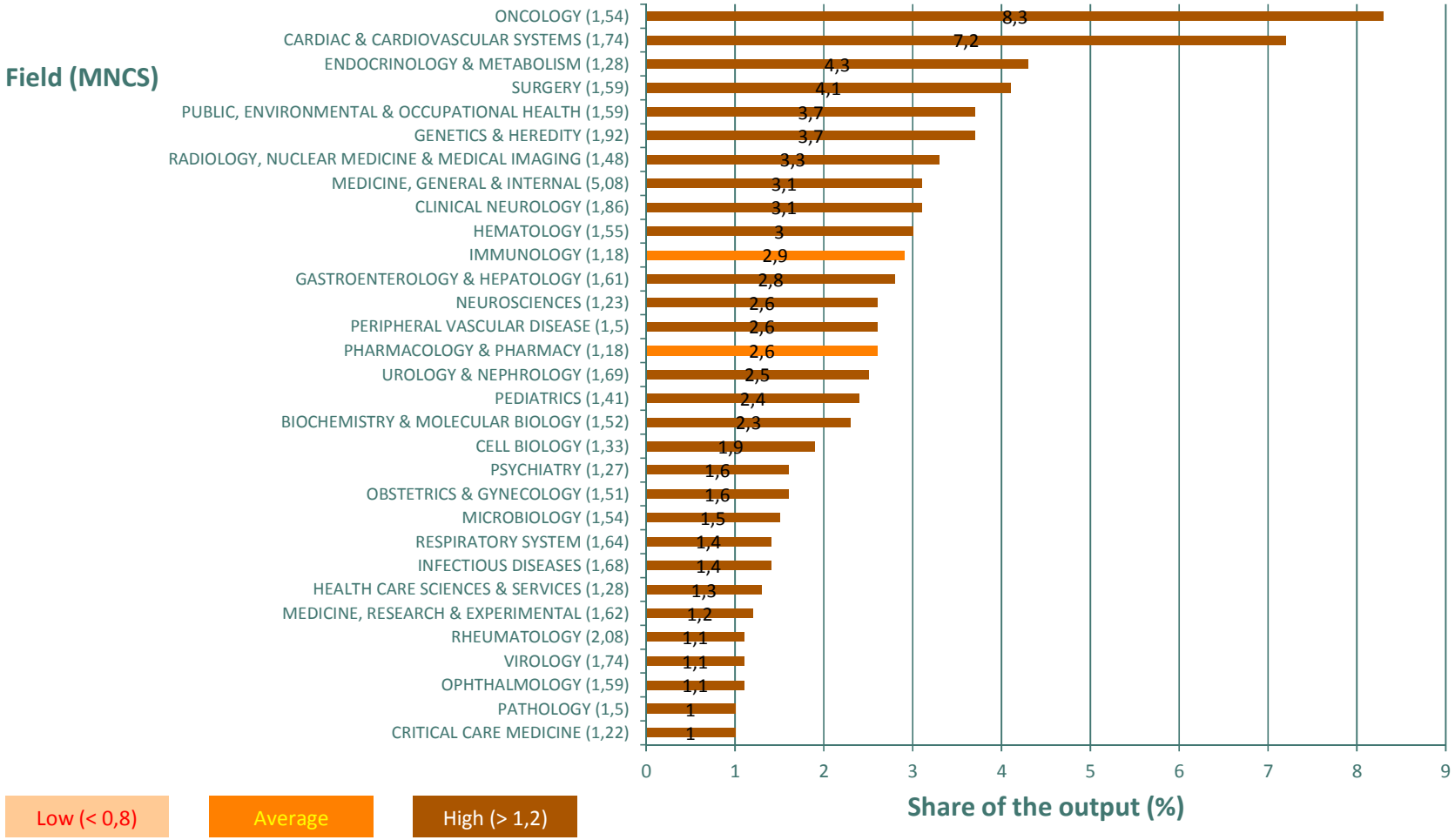


Figure 1b: Output and normalized impact per field (2010-2014/2015)
Erasmus MC

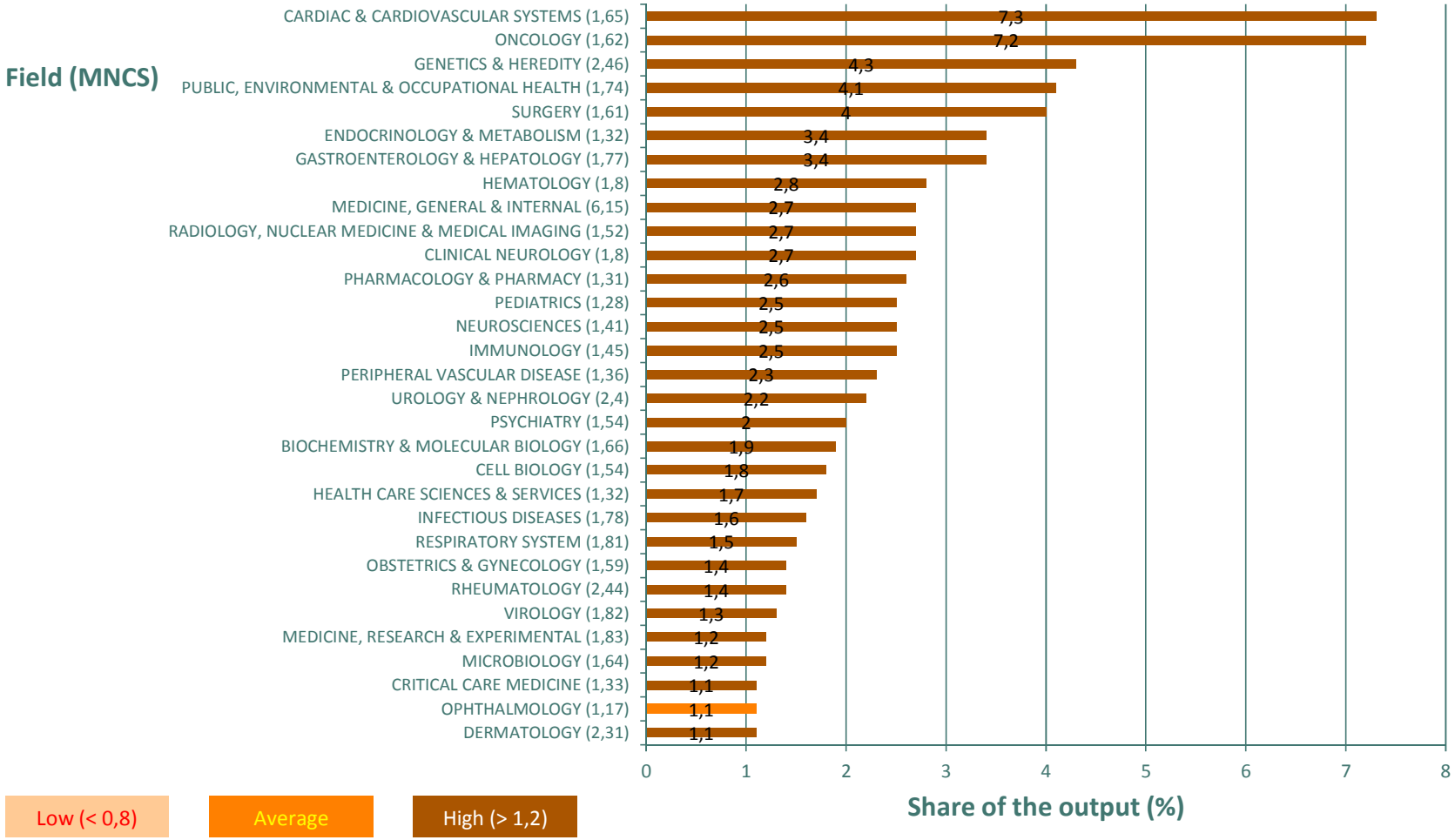


Figure 2a: Output and normalized impact per field (1998-2014/2015)
LU MC

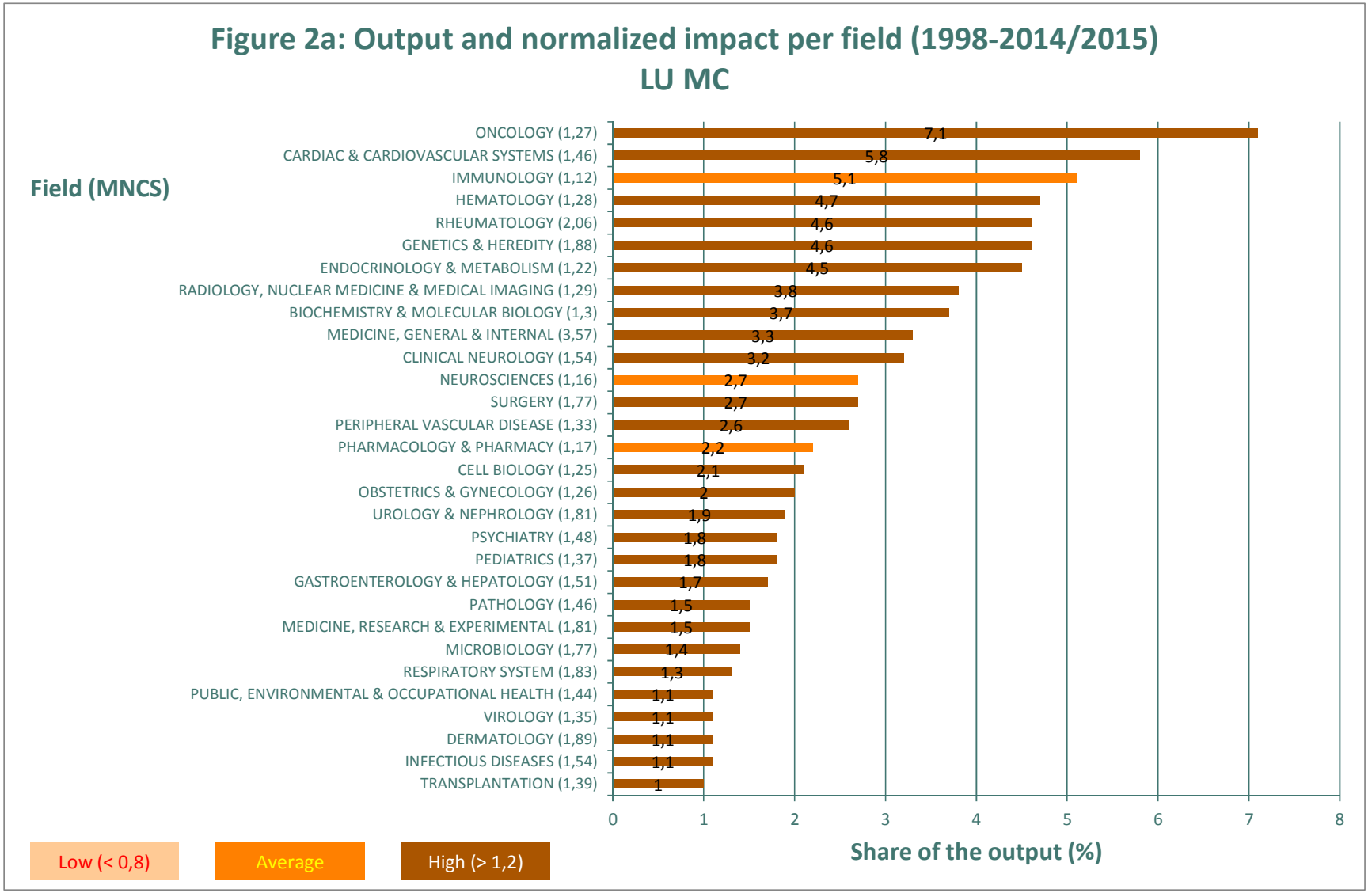


Figure 2b: Output and normalized impact per field (2010-2014/2015)
LU MC

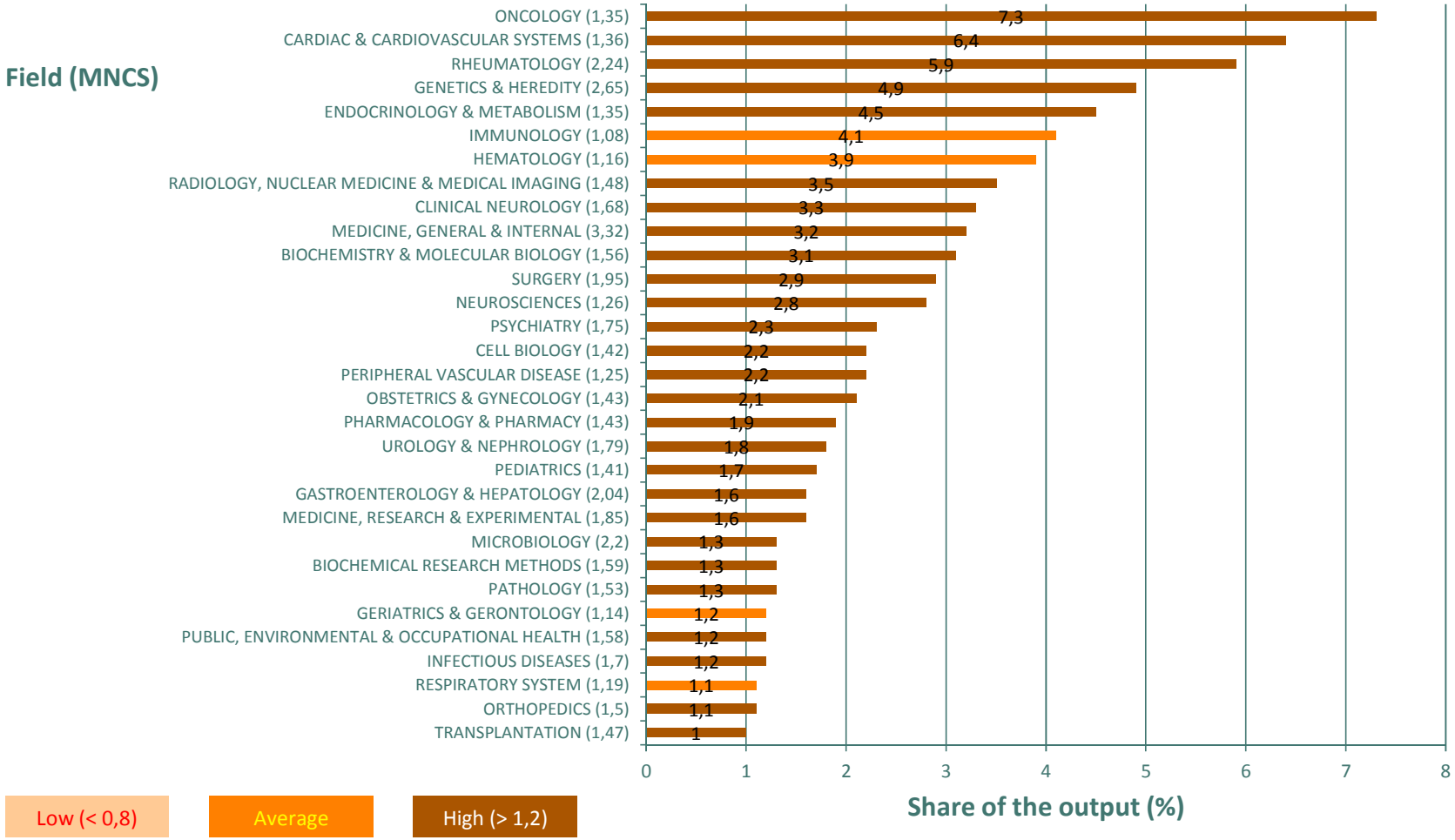


Figure 3a: Output and normalized impact per field (1998-2014/2015)
Radboud UMC

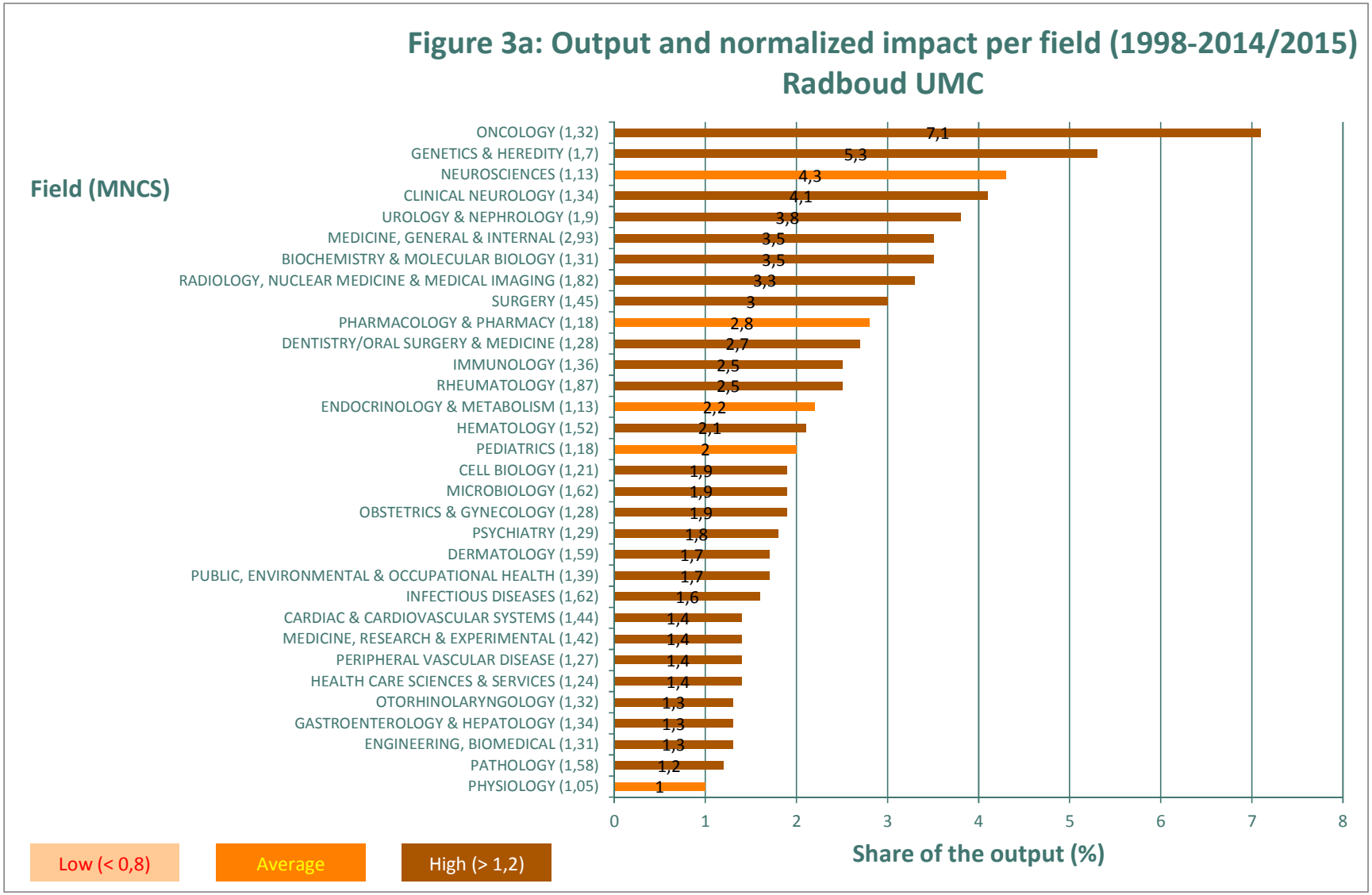


Figure 3b: Output and normalized impact per field (2010-2014/2015)
Radboud UMC

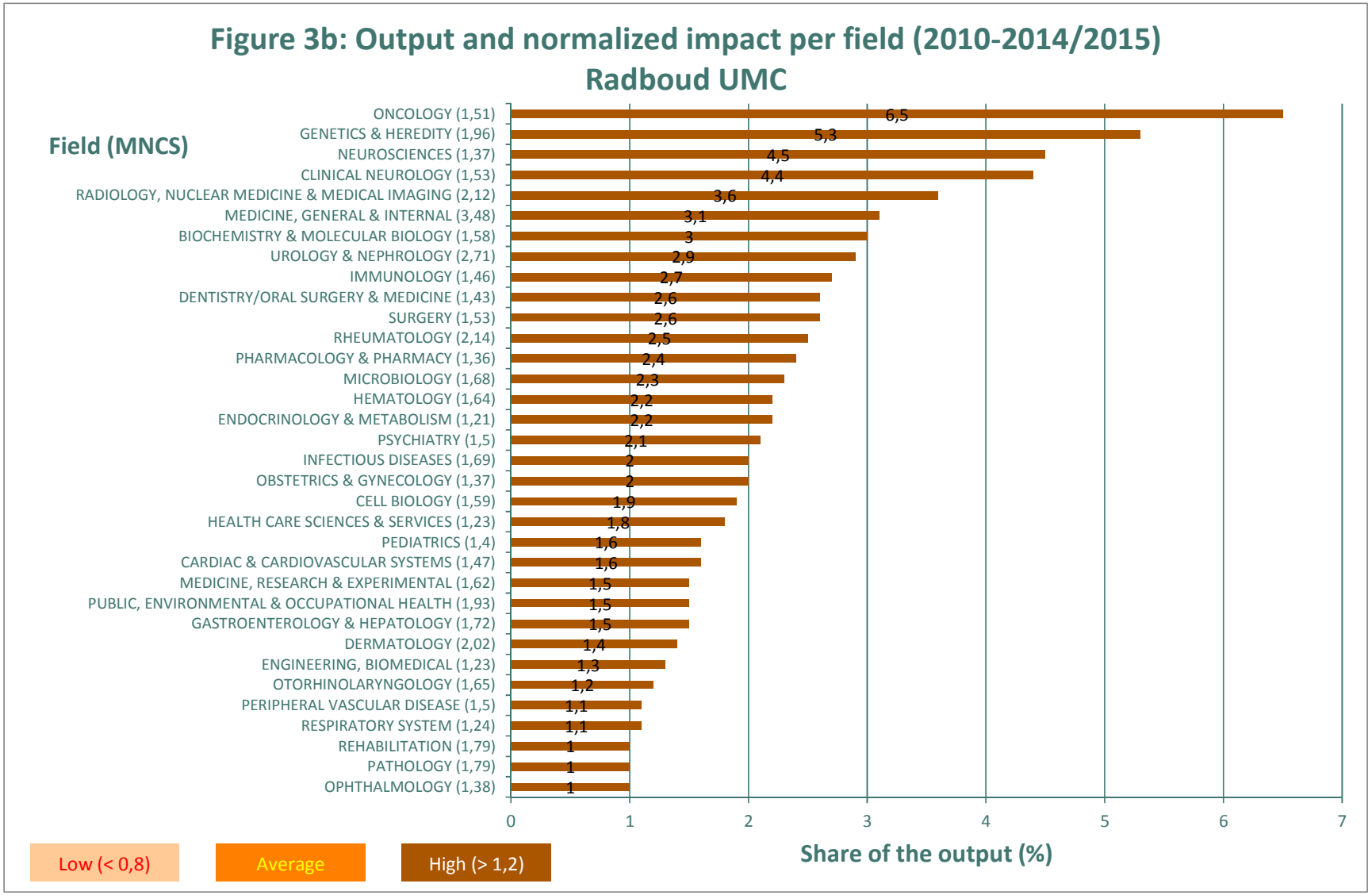


Figure 4a: Output and normalized impact per field (1998-2014/2015)
UMC Maastricht

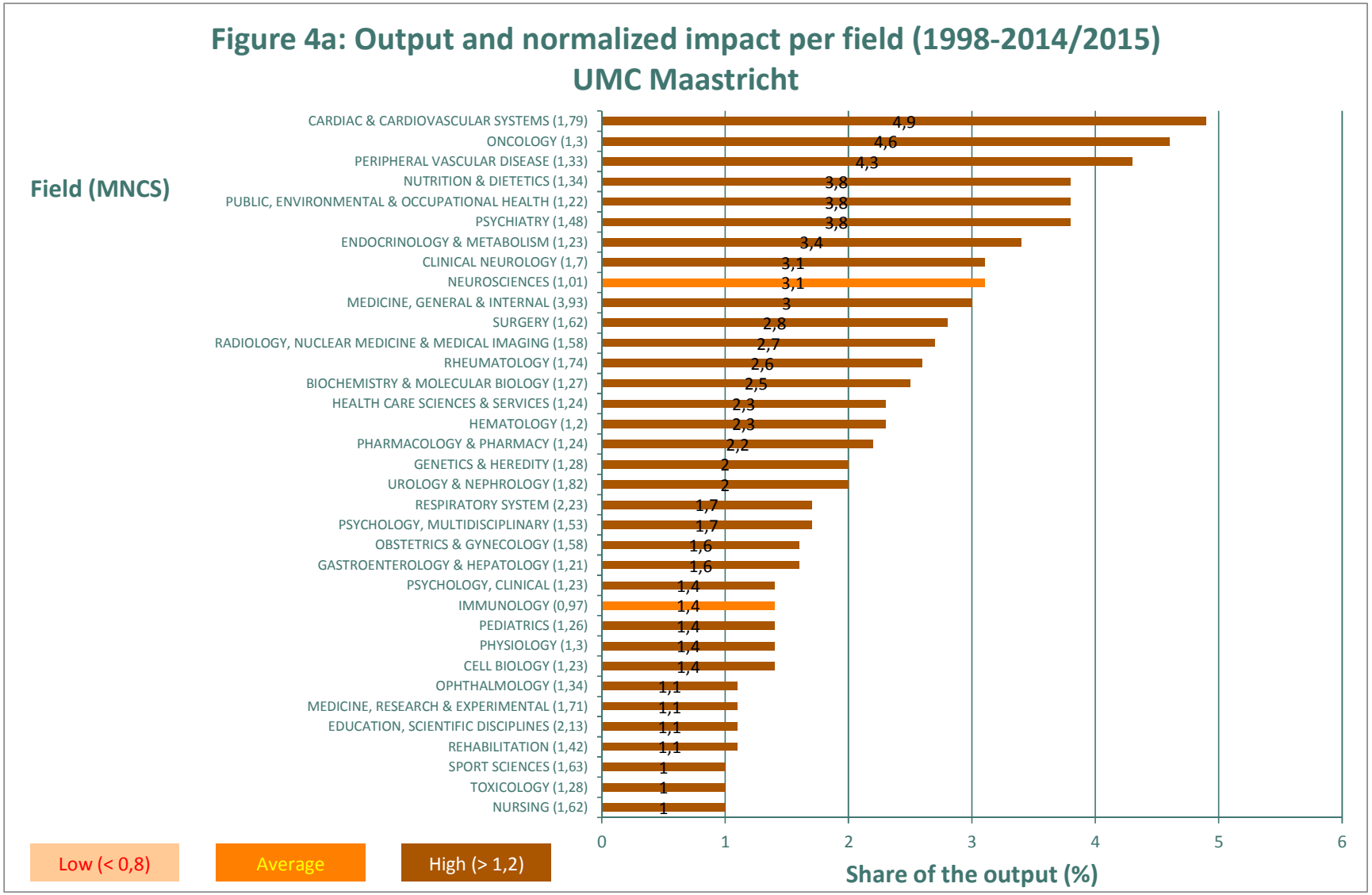


Figure 4b: Output and normalized impact per field (2010-2014/2015)
UMC Maastricht

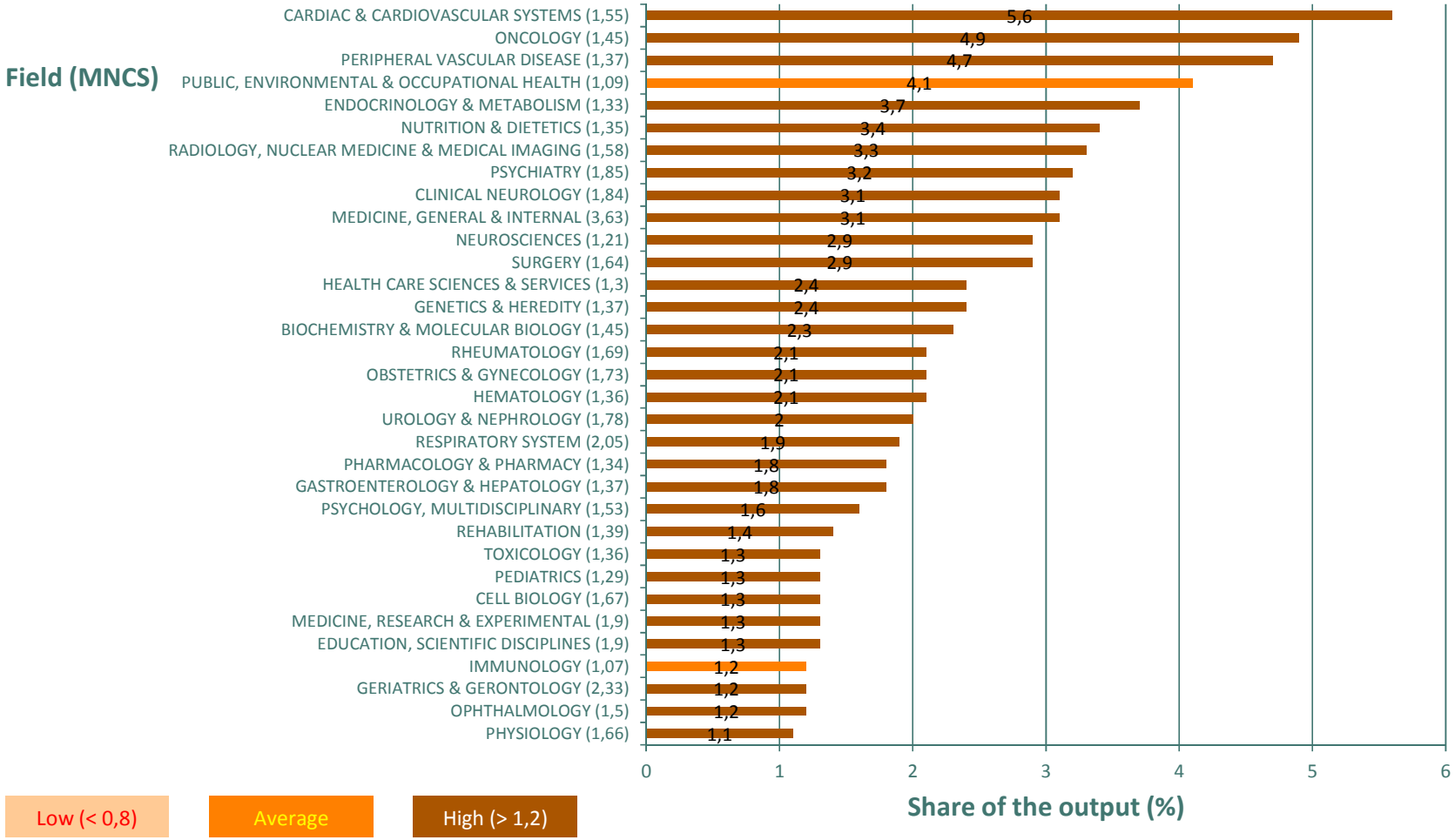


Figure 5a: Output and normalized impact per field (1998-2014/2015)
UMCG

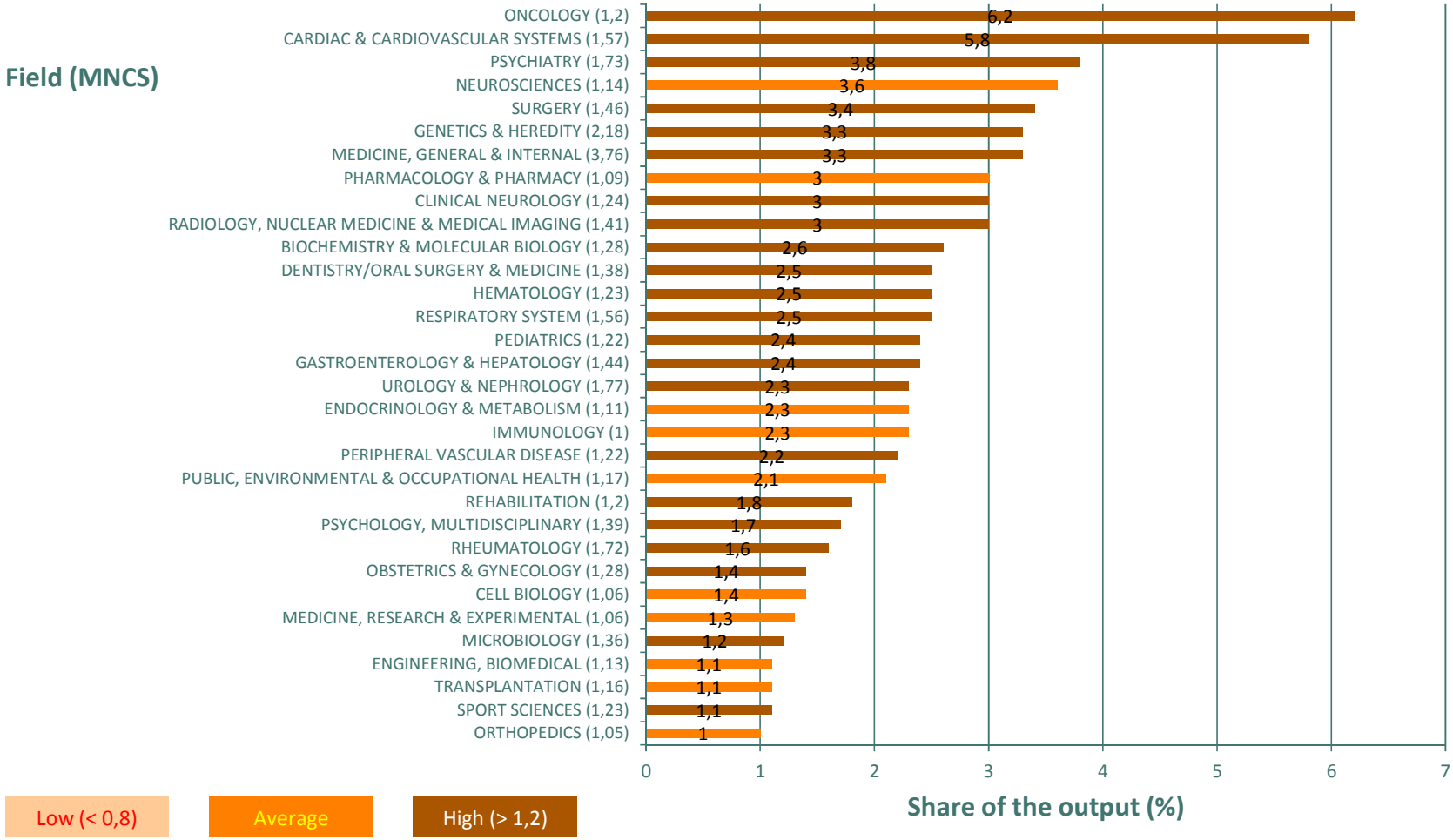


Figure 5b: Output and normalized impact per field (2010-2014/2015)
UMCG

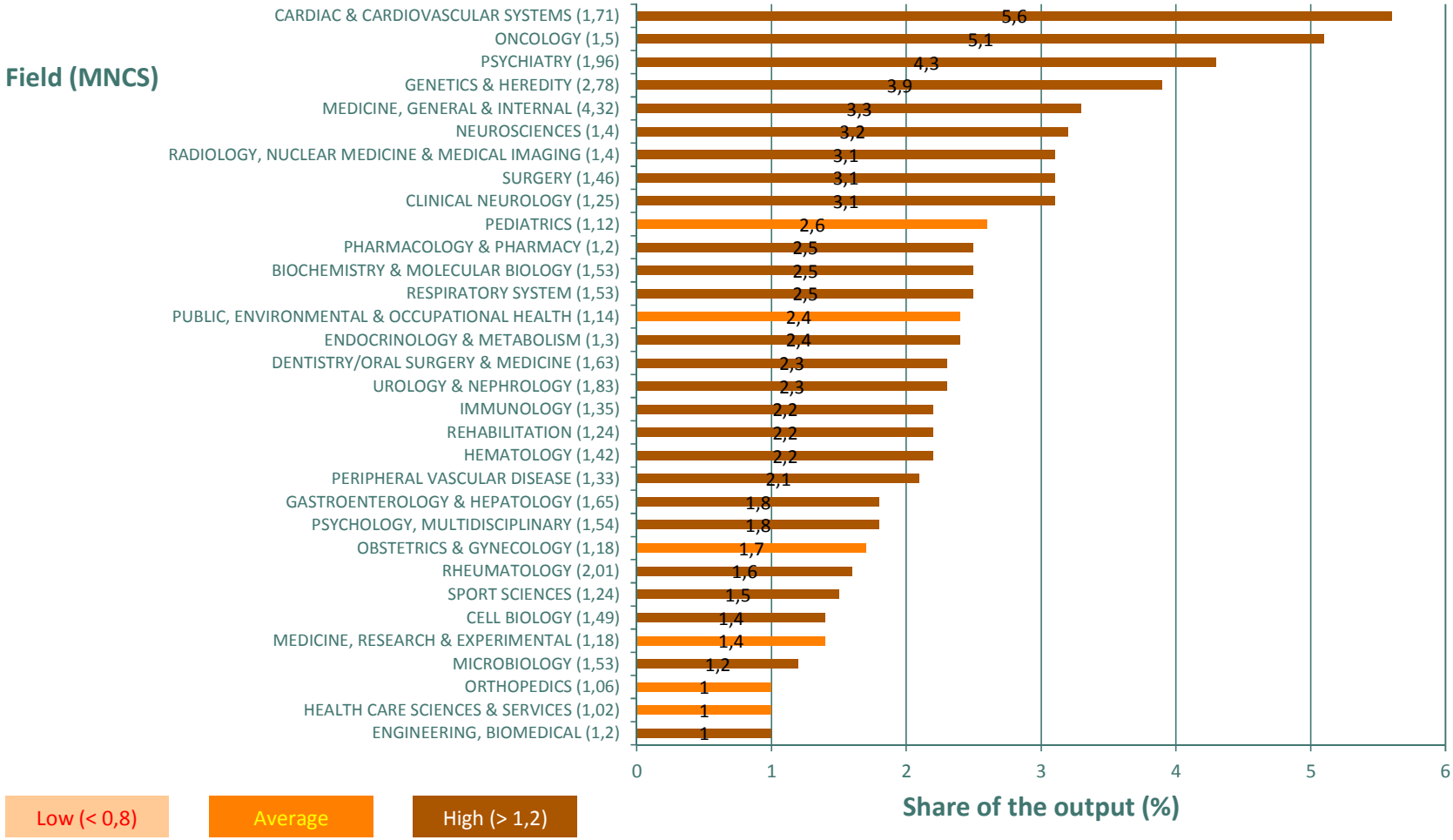


Figure 6a: Output and normalized impact per field (1998-2014/2015)
UU UMC

Figure 6b: Output and normalized impact per field (2010-2014/2015)
UU UMC

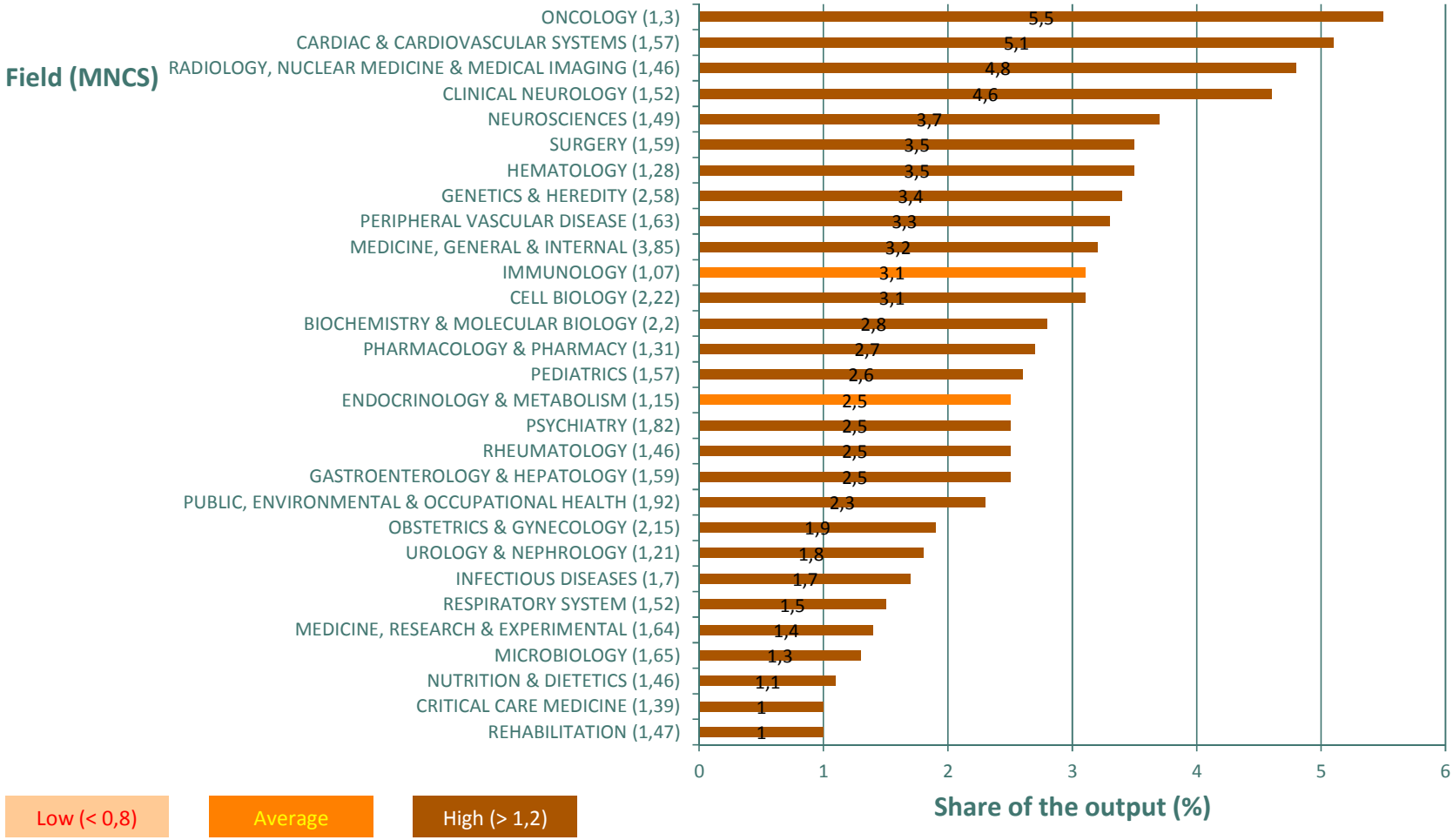


Figure 7a: Output and normalized impact per field (1998-2014/2015)
UvA AMC

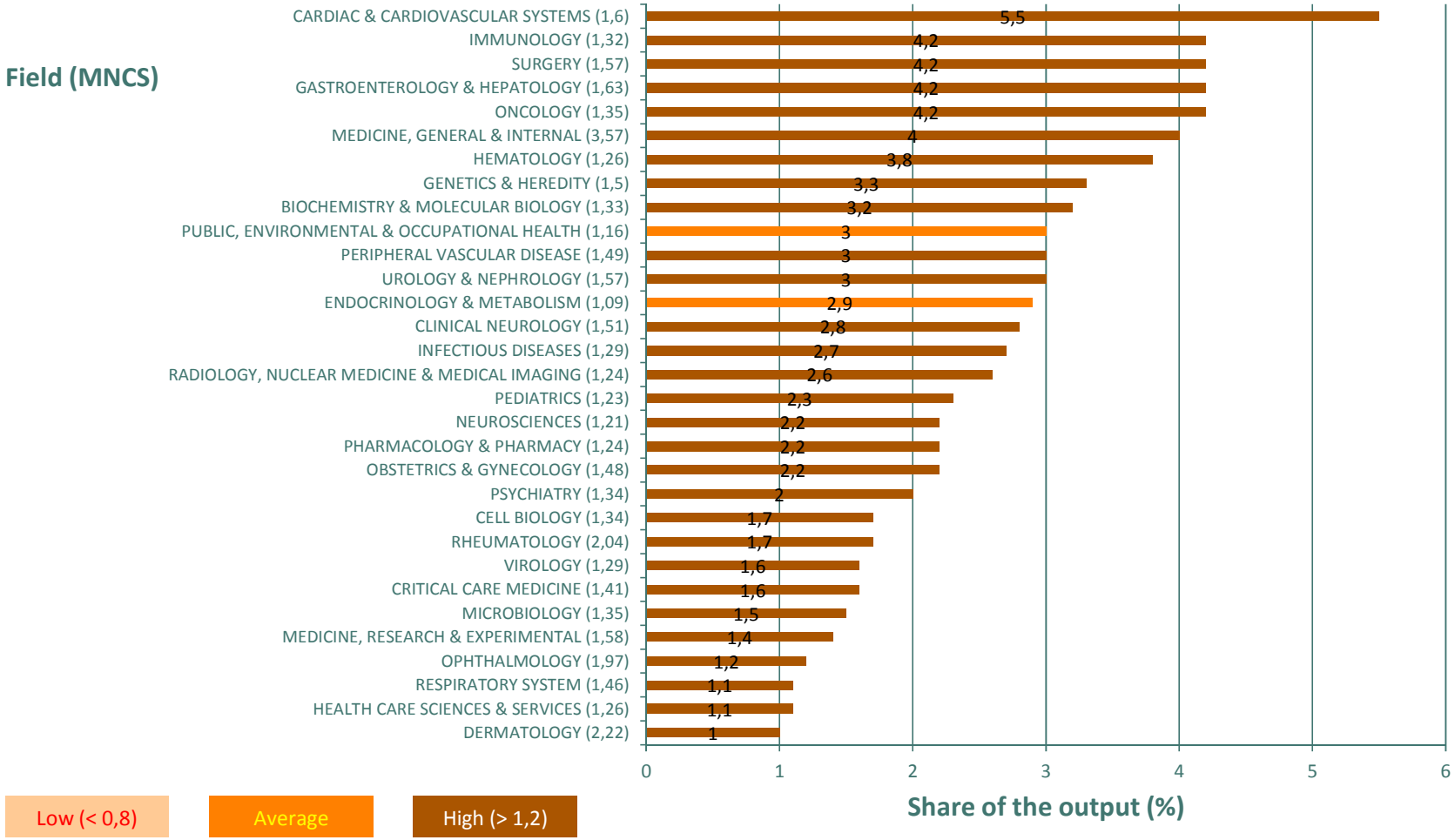


Figure 7b: Output and normalized impact per field (2010-2014/2015)
UvA AMC

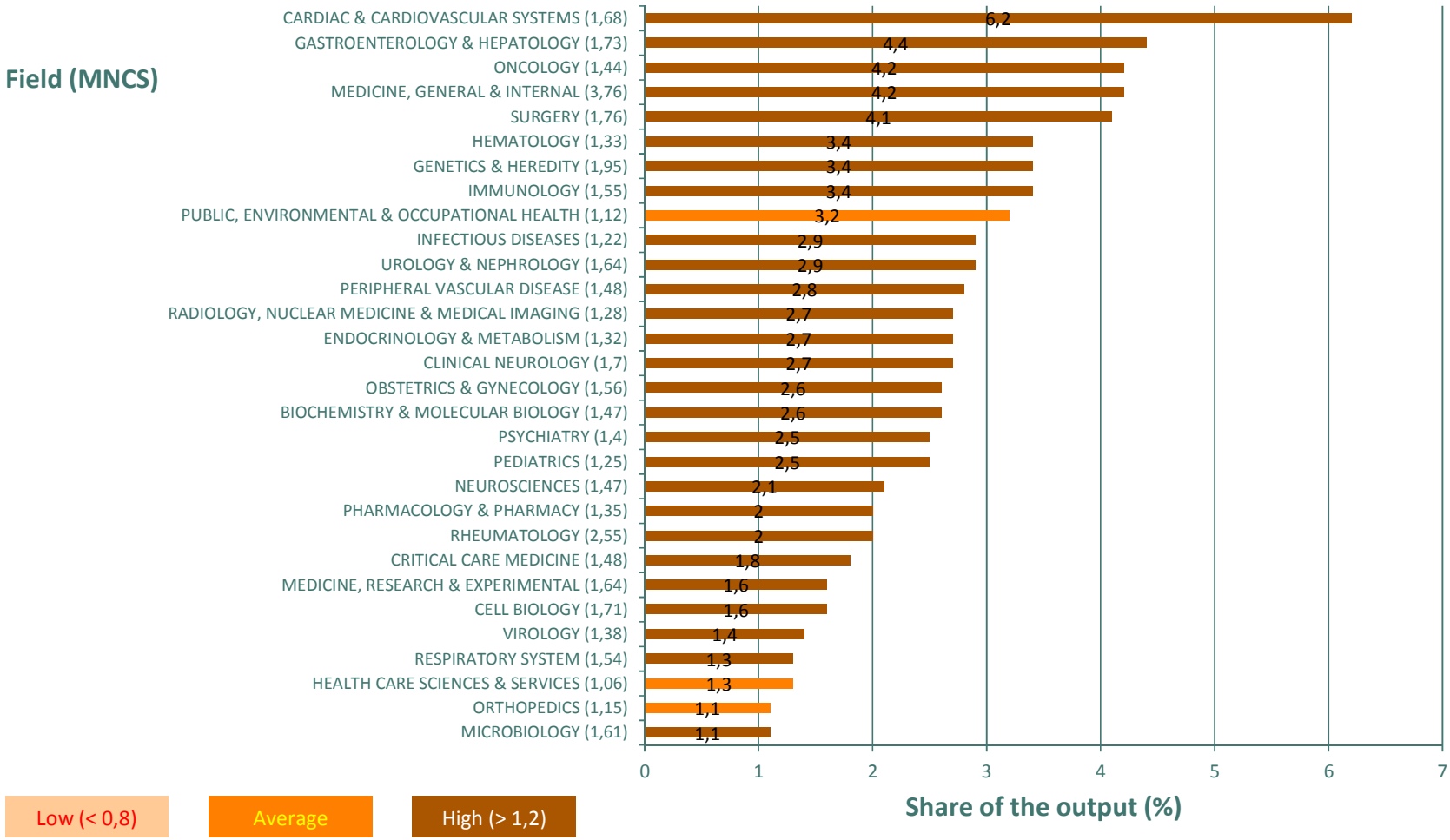


Figure 8a: Output and normalized impact per field (1998-2014/2015)

VUmc

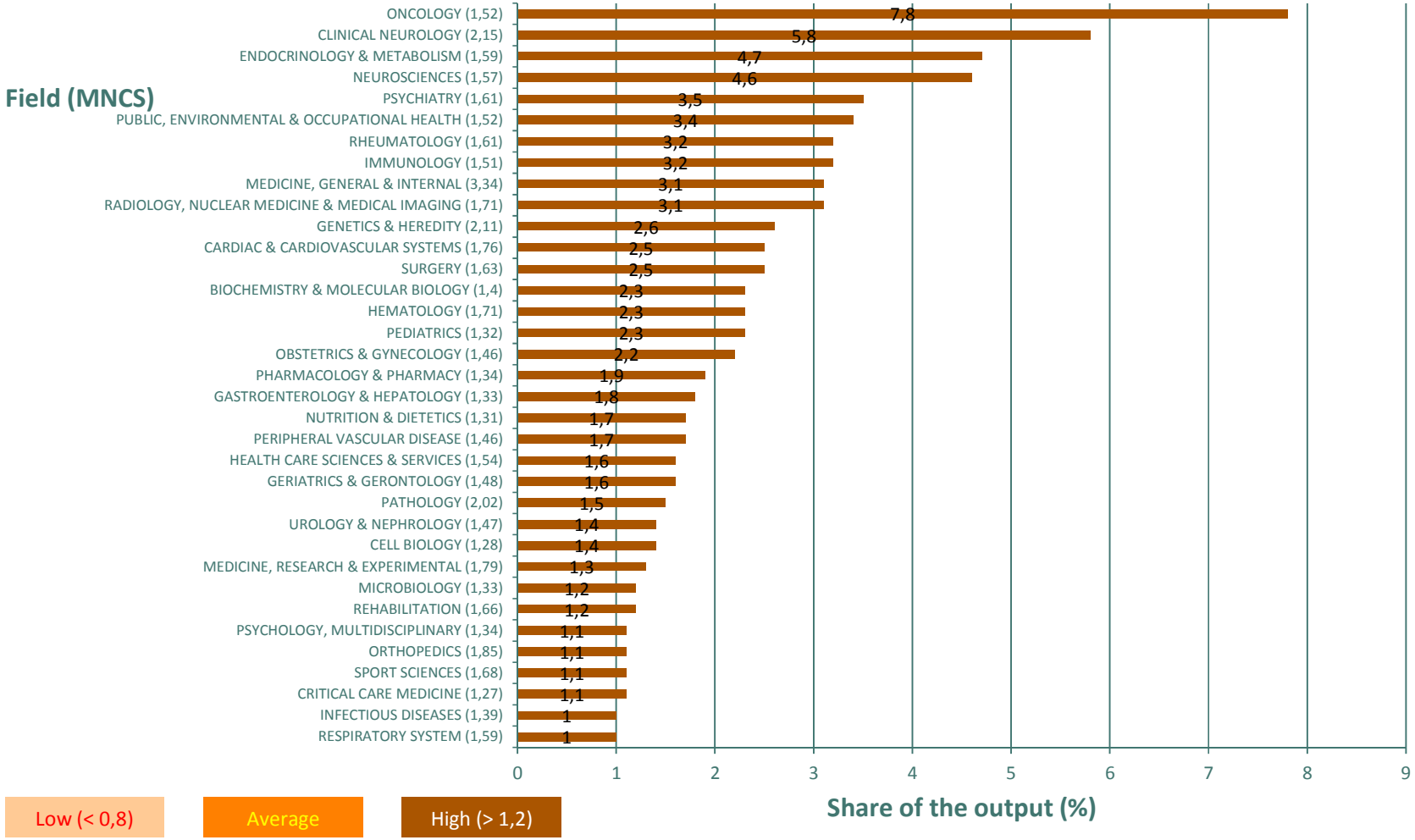


Figure 8b: Output and normalized impact per field (2010-2014/2015)

VUmc

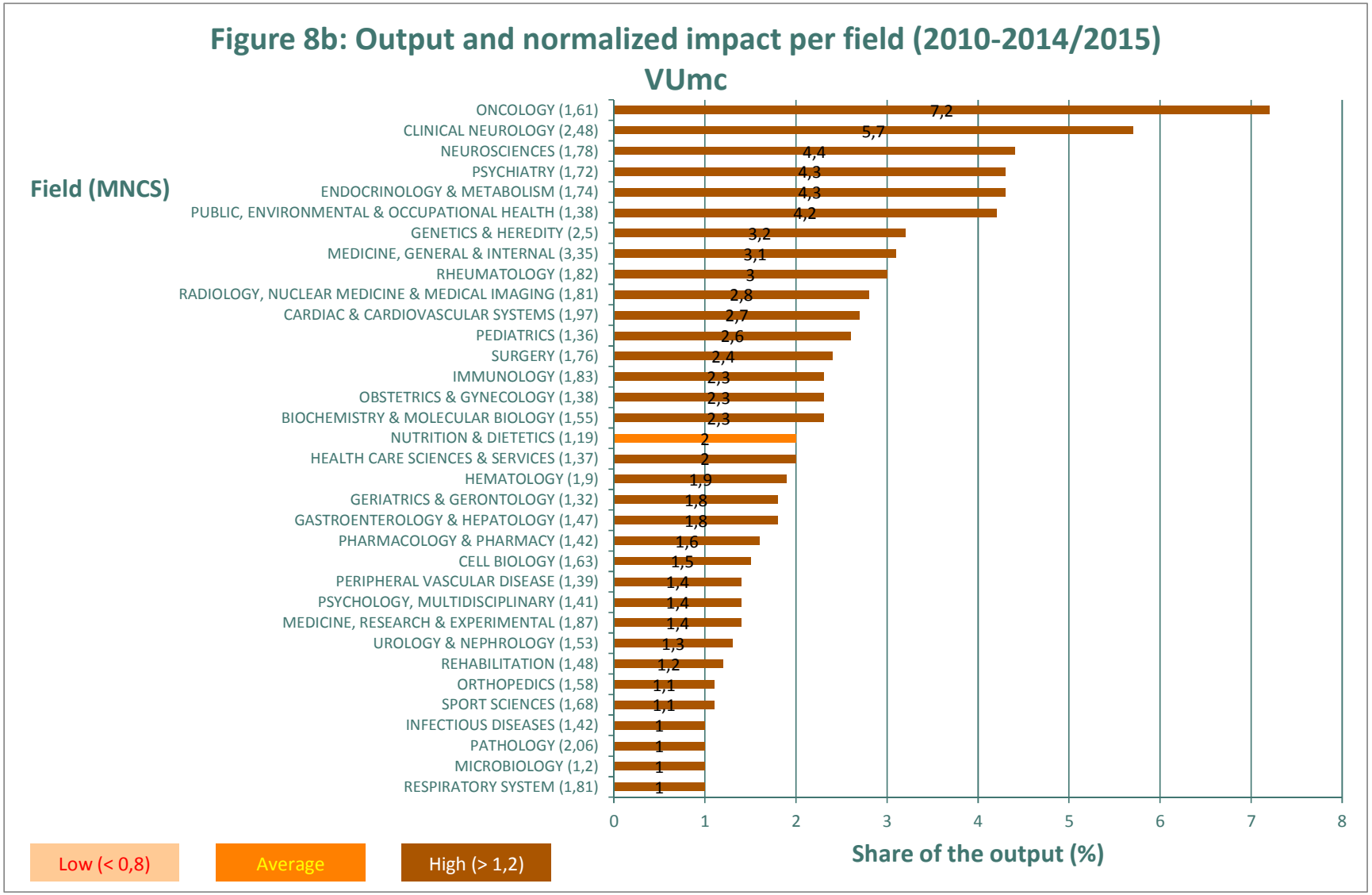


Figure 9a: Output and normalized impact per field (1998-2014/2015)
All UMCs together

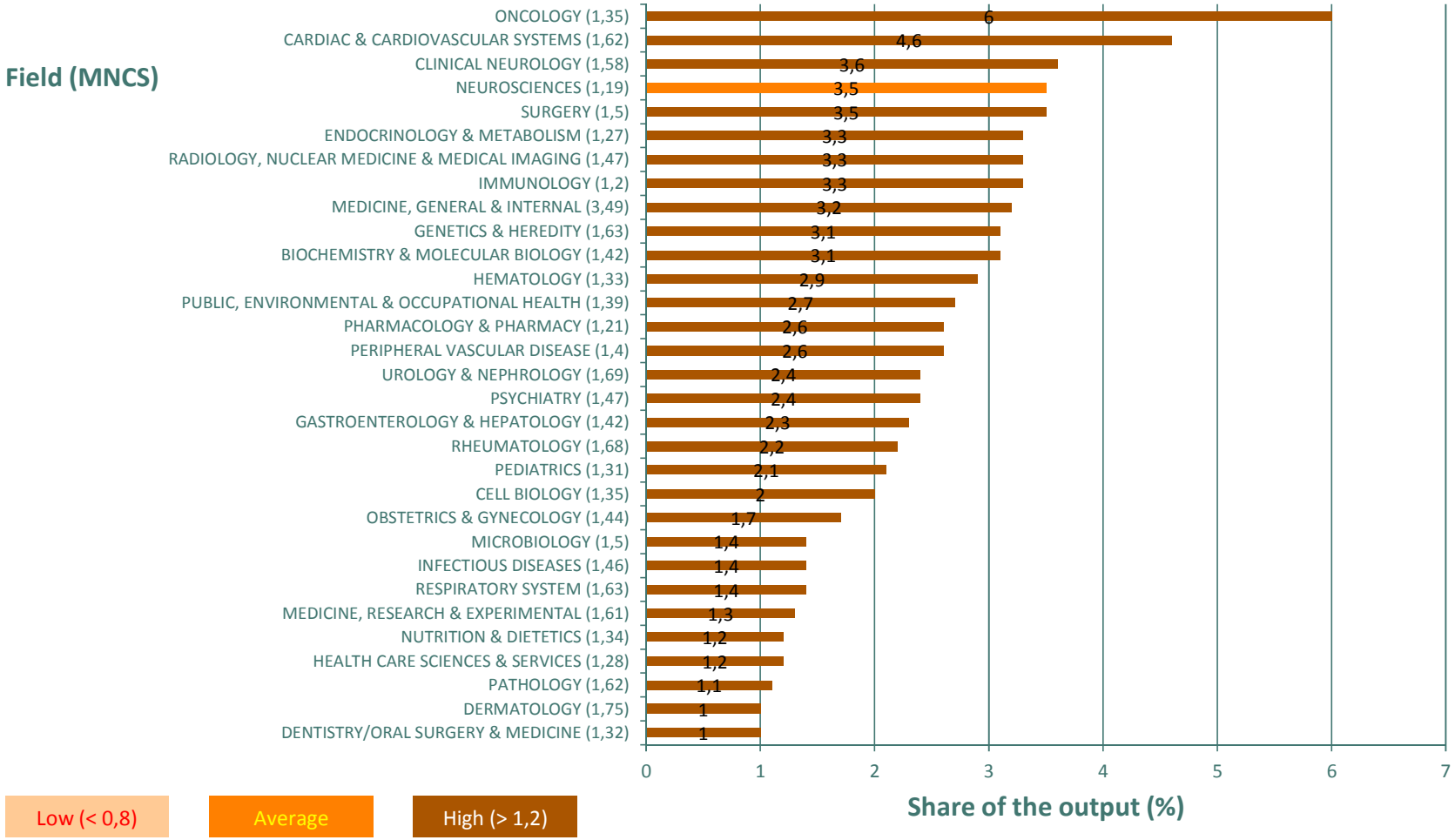
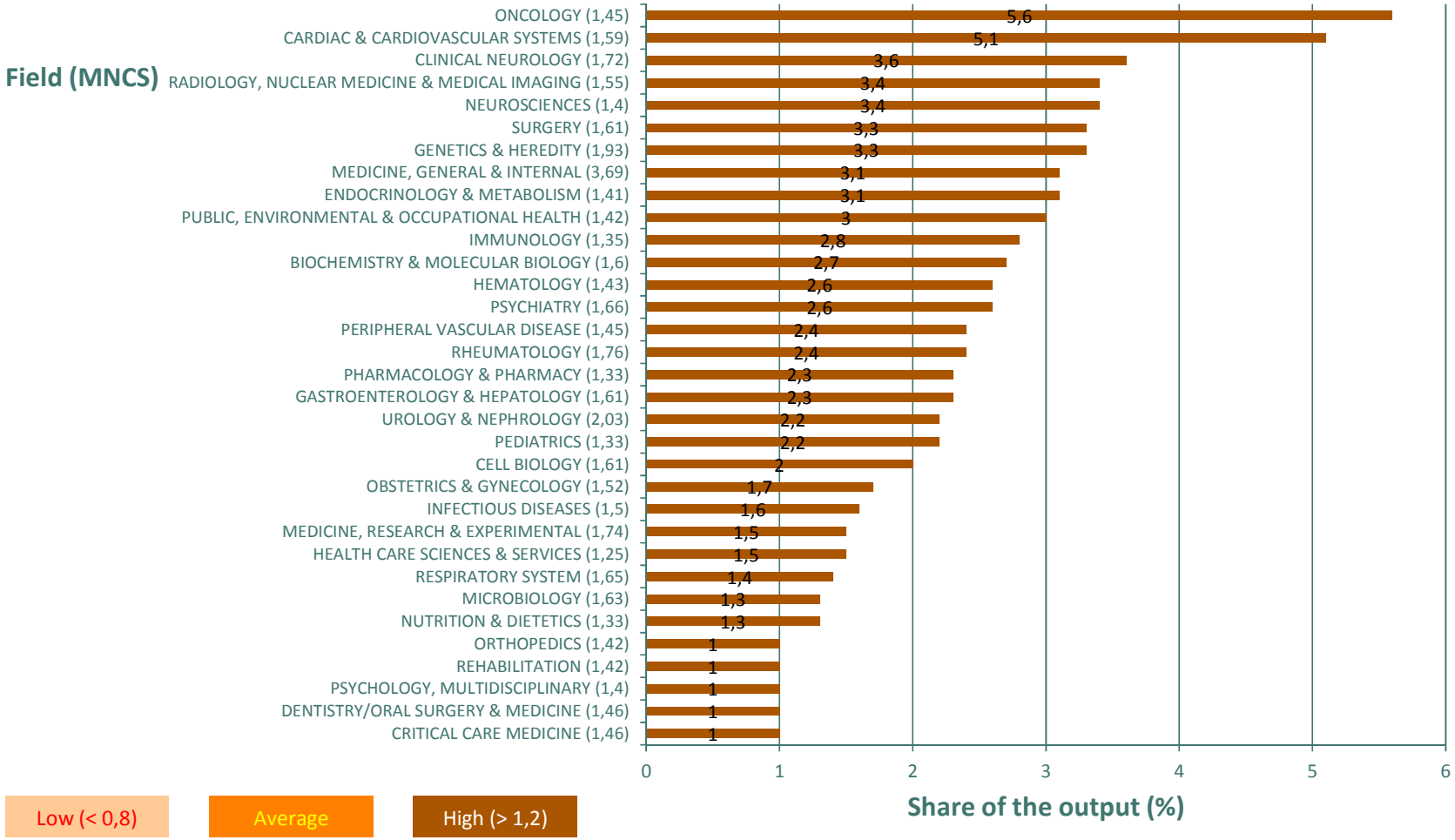


Figure 9b: Output and normalized impact per field (2010-2014/2015)
All UMCs together



2.3 Landscape of Dutch academic medical centers

In this section, the focus is on various aspects of scientific activity, like first authorships, international cooperation, single address output. As this section contains descriptions on various aspects of scientific research and publishing, its contents summarizes the situation among the Dutch academic medical centers.

Figure 10a and **Figure 10b** contain the combined insight of output numbers in the period 1998-2014/2015 and 2010-2014/2015 respectively, and the field normalized impact (***MNCS***) of this output. **Figure 11a** contains the combined insight of output numbers in the period 1998-2014/2015 and the journal-to-field normalized impact (***MNJS***) of this output, while **Figure 11b** contains similar information for the period 2010-2014/2015. **Figure 12a** contains the combined insight of output numbers in the period 1998-2014/2015 and the journal impact (***MNCS/MNJS***) of this output, whereas **Figure 12b** contains similar data for the period 2010-2014/2014.

Figures 13a to **13c** display the trend scores for the three impact indicators displayed in the three previous sets of graphs, ***MNCS***, ***MNJS***, and ***MNCS/MNJS***. This is added to show the development behind the two snap shots presented by the previous graphs.

Figure 14a and **Figure 14b** contain the output resulting from *first authorships* as a share of the total output of the eight Dutch academic medical centers, combined with the MNCS values of that part of their output, in the periods 1998-2014/2015 and 2010-2014/2015.

Figure 15 contains the trend impact data behind the development of first authored publications by each of the Dutch UMCS.

Figure 16a and **Figure 16b** focus on the part of the output of the Dutch academic medical centers that results from *international collaboration*, while **Figure 18a** and **Figure 18b** concentrate on the share of the output that is the results from every *individual* academic medical center, in which no other institute is involved.

Figures 17 and **19** contain trend impact data (***MNCS***) for both the characteristics of scientific activity, international co-publishing and single address output, to show the development behind the two sets of graphs presented previously.

Figure 10a: Output compared to field-normalized impact, 1998-2014/2015

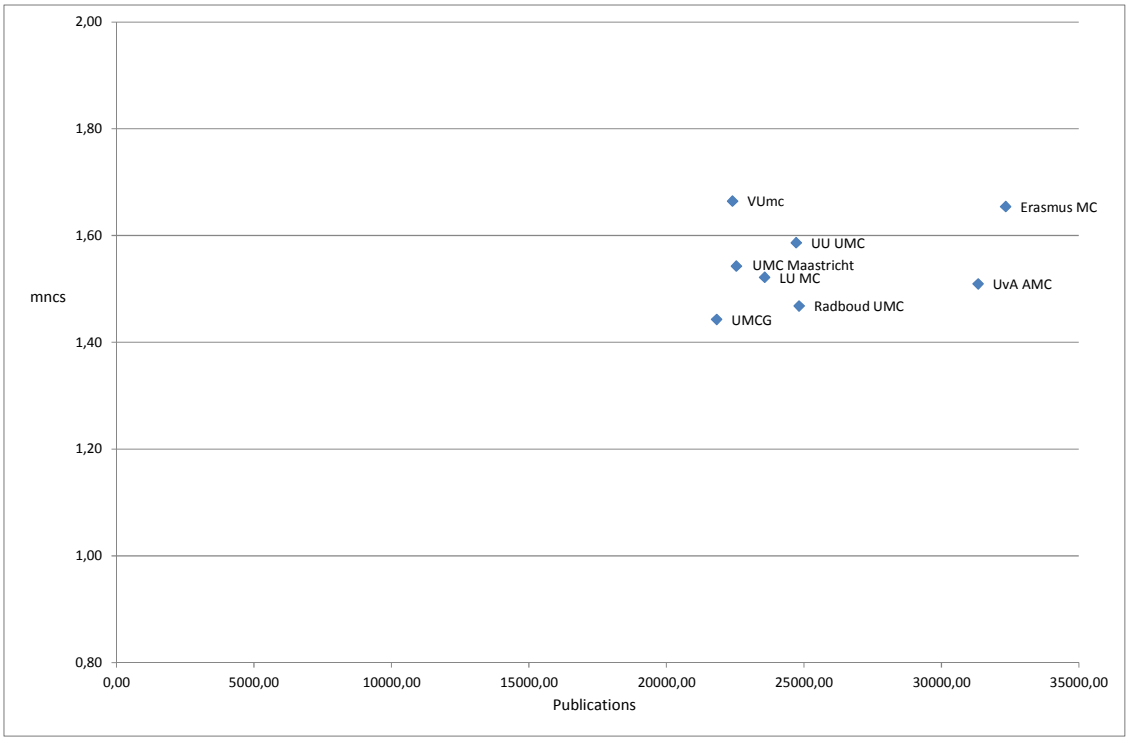


Figure 10b: Output compared to field-normalized impact, 2010-2014/2015

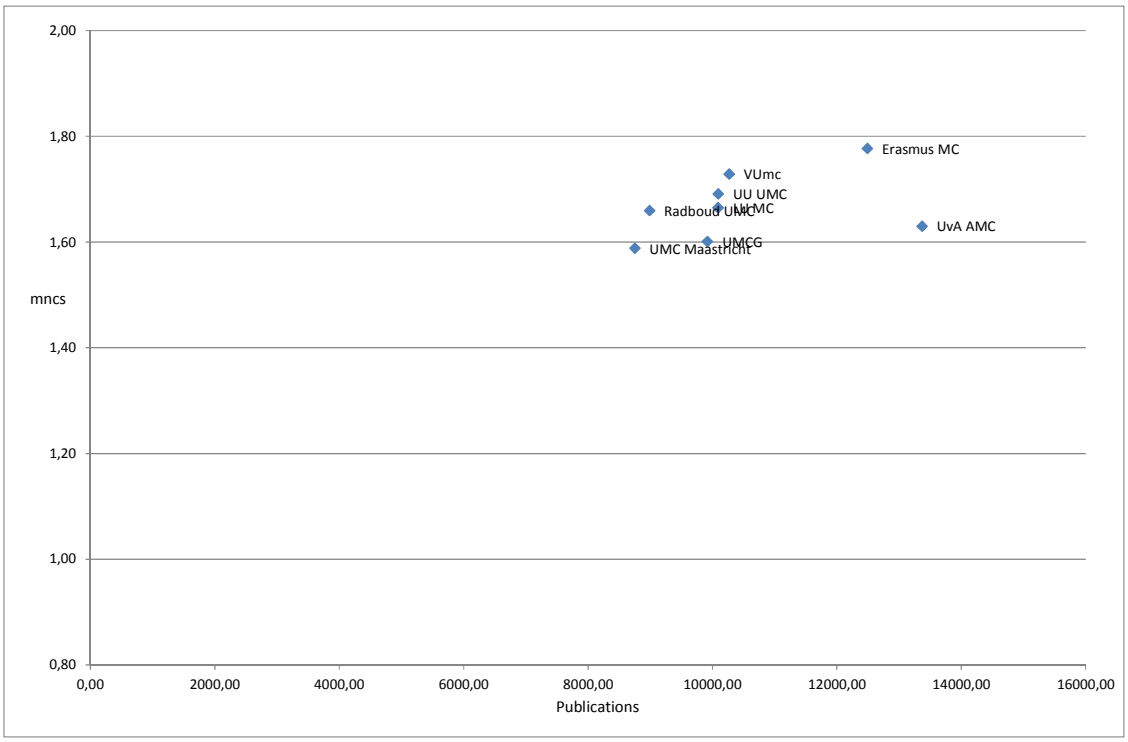


Figure 11a: Output compared to journal-to-field impact, 1998-2014/2015

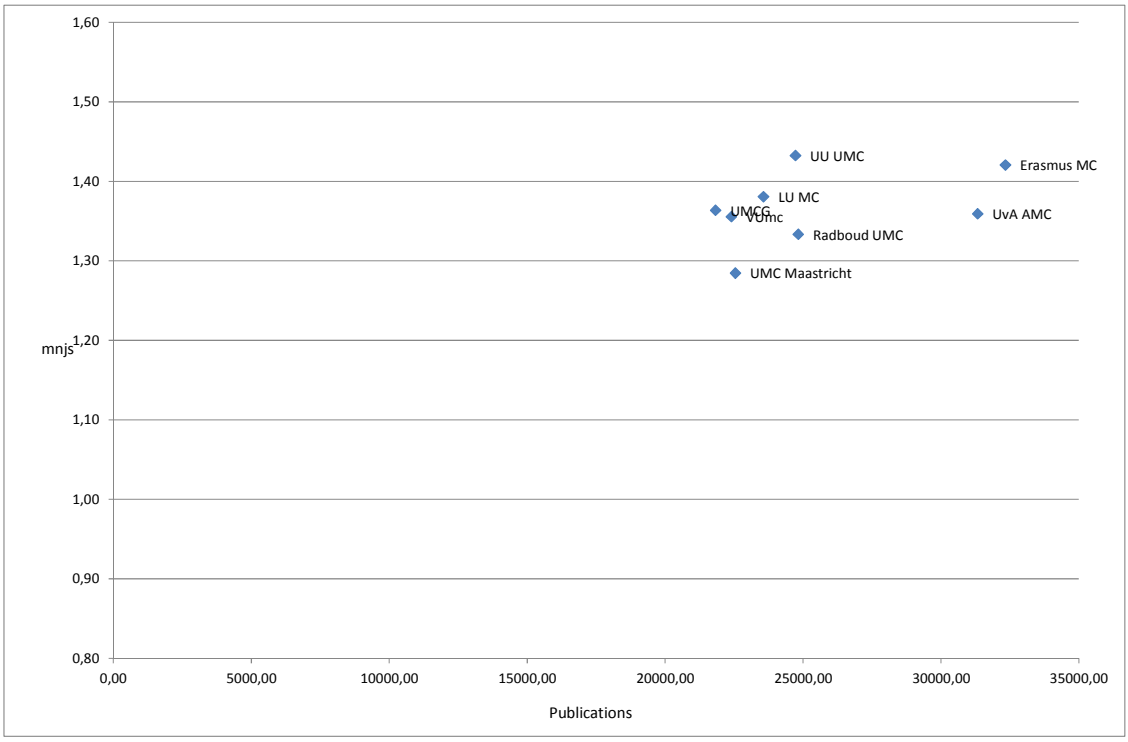


Figure 11b: Output compared to journal-to-field impact, 2010-2014/2015

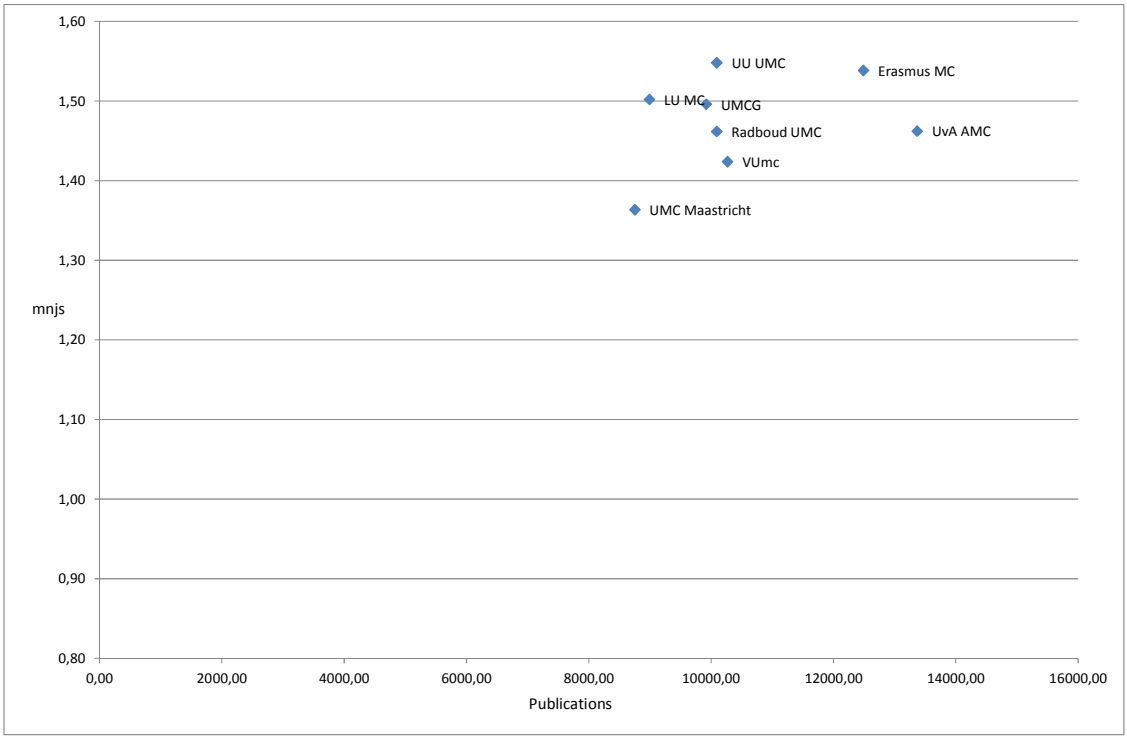


Figure 12a: Output compared to average journal impact, 1998-2014/2015

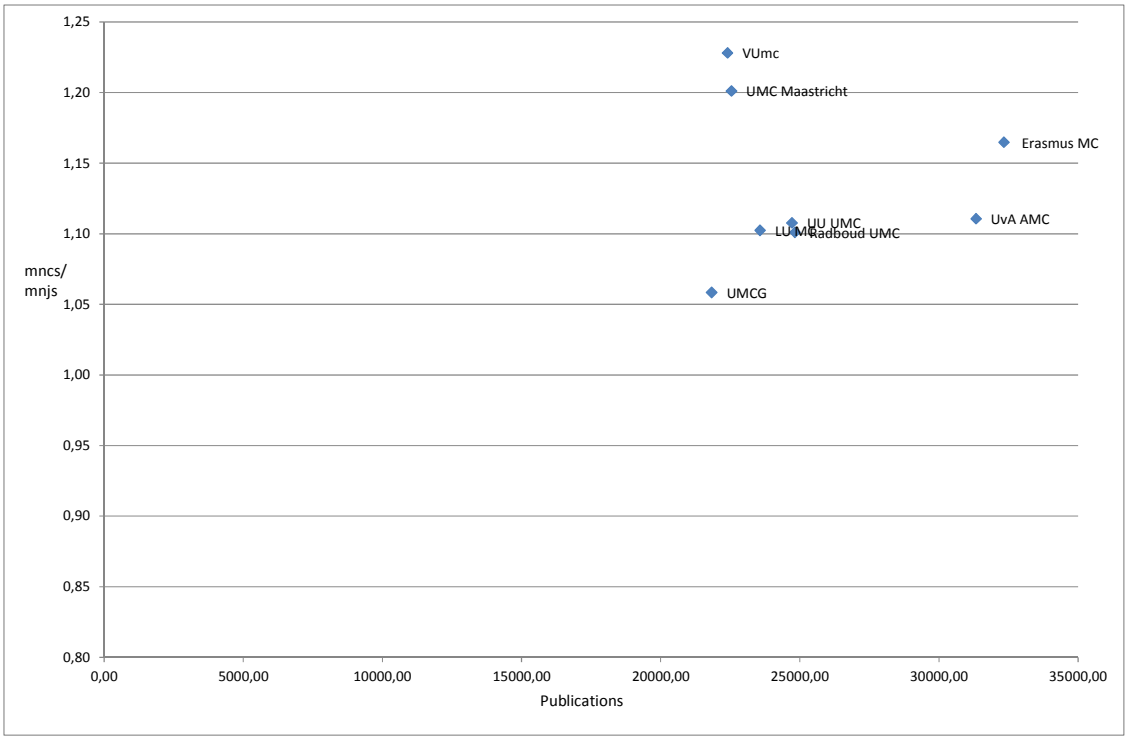


Figure 12b: Output compared to average journal impact, 2010-2014/2015

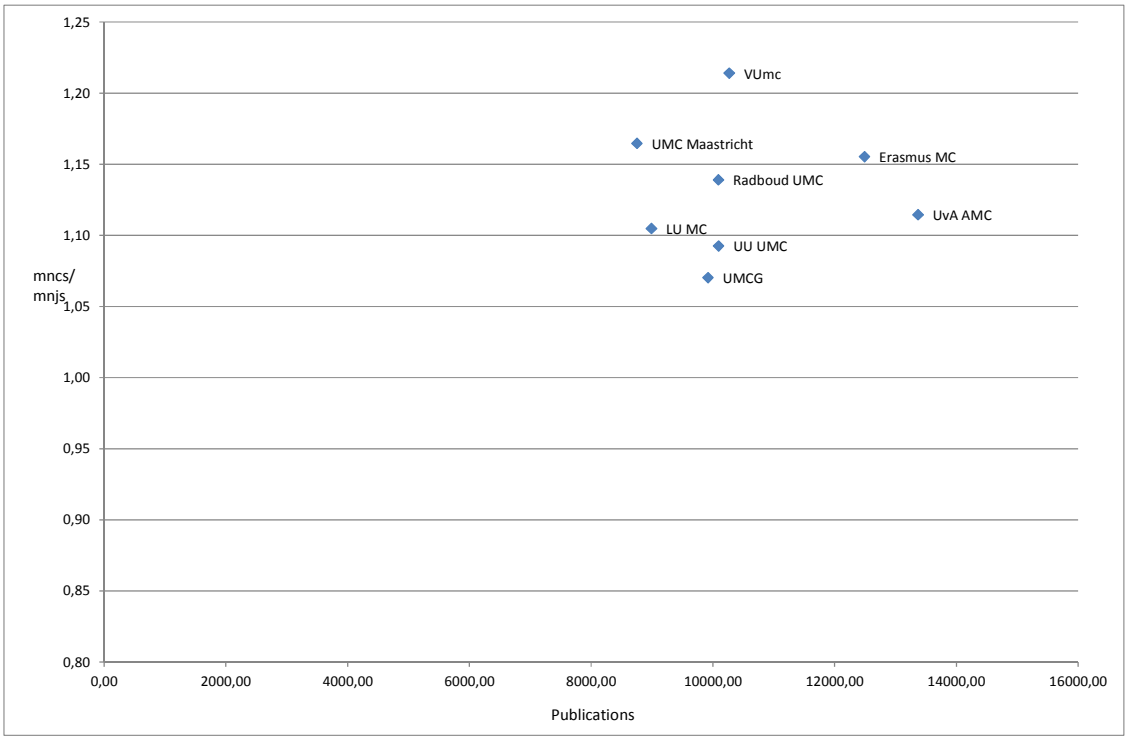


Figure 13a: Trend analysis of the field-normalized impact (MNCS) for all Dutch UMCS, 1998-2014/2015

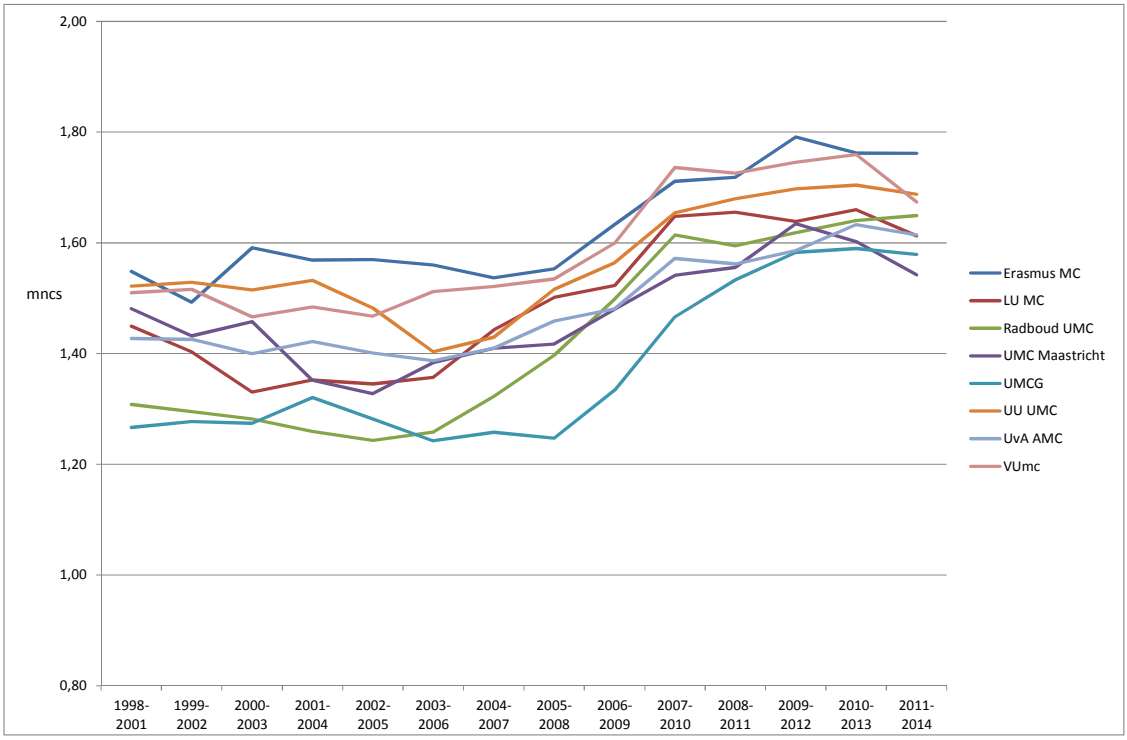


Figure 13b: Trend analysis of the journal-to-field normalized impact (MNJS) for all Dutch UMCS, 1998-2014/2015

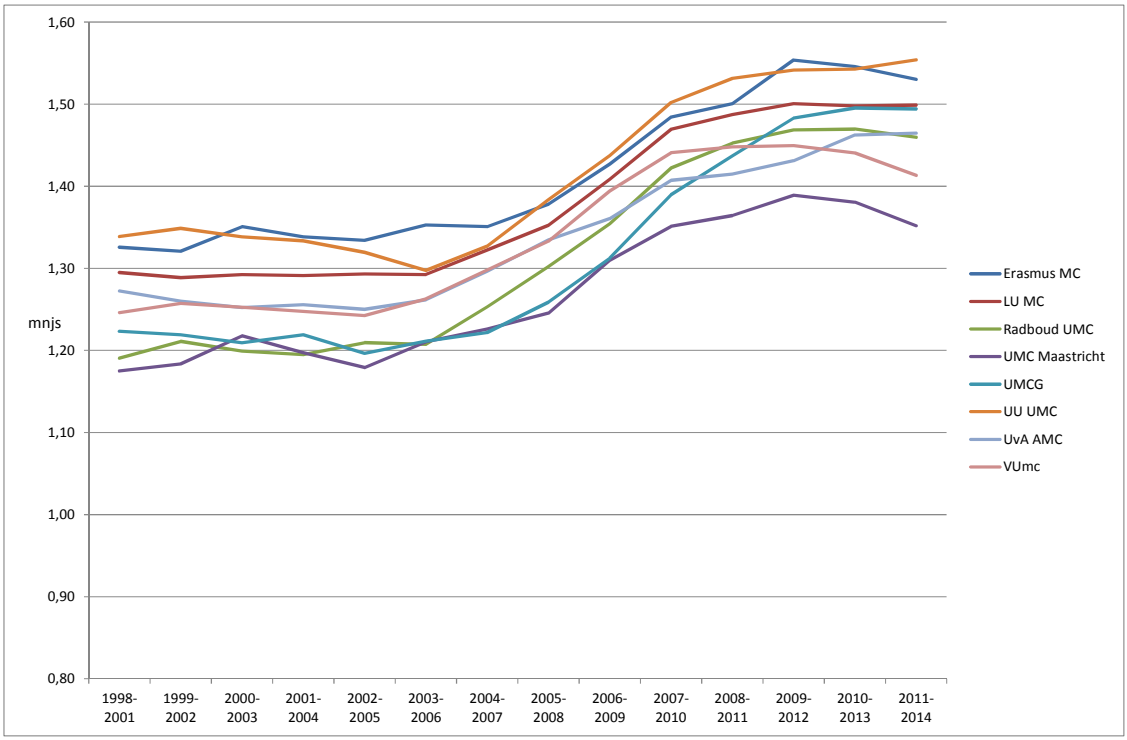


Figure 13c: Trend analysis of the average journal impact, (MNCS/MNJS) for all Dutch UMCS, 1998-2014/2015

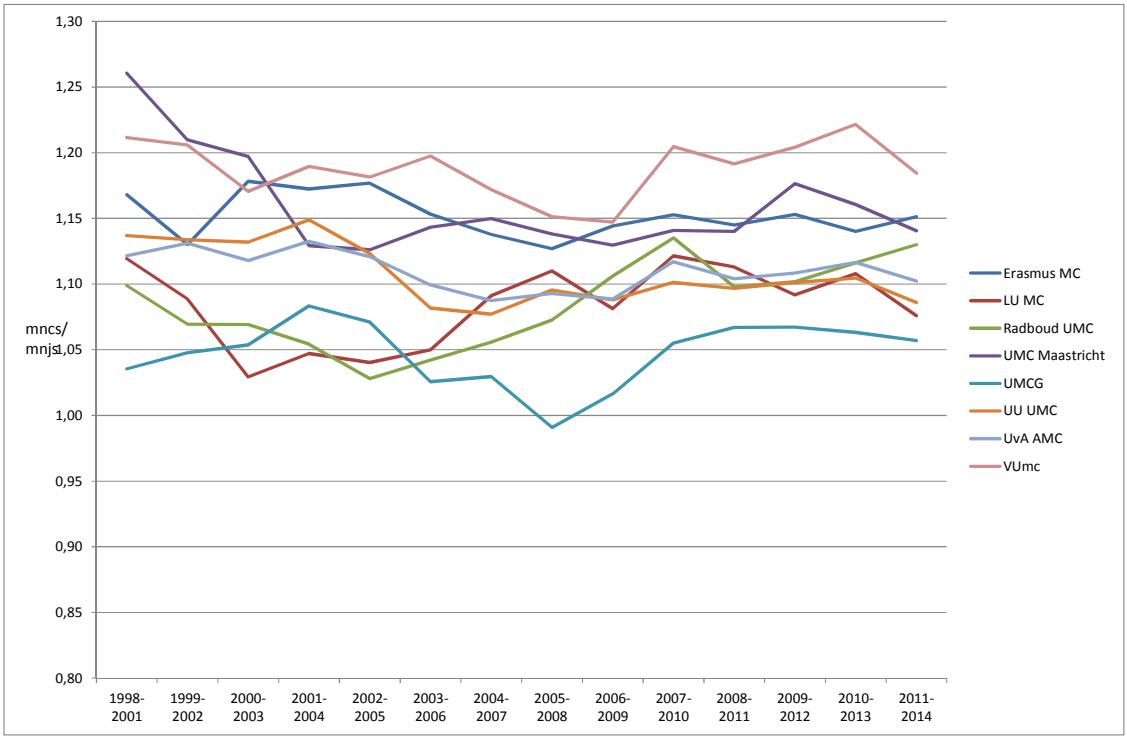


Figure 14a: Output compared to field-normalized impact (MNCS), first authorships only, 1998-2014/2015

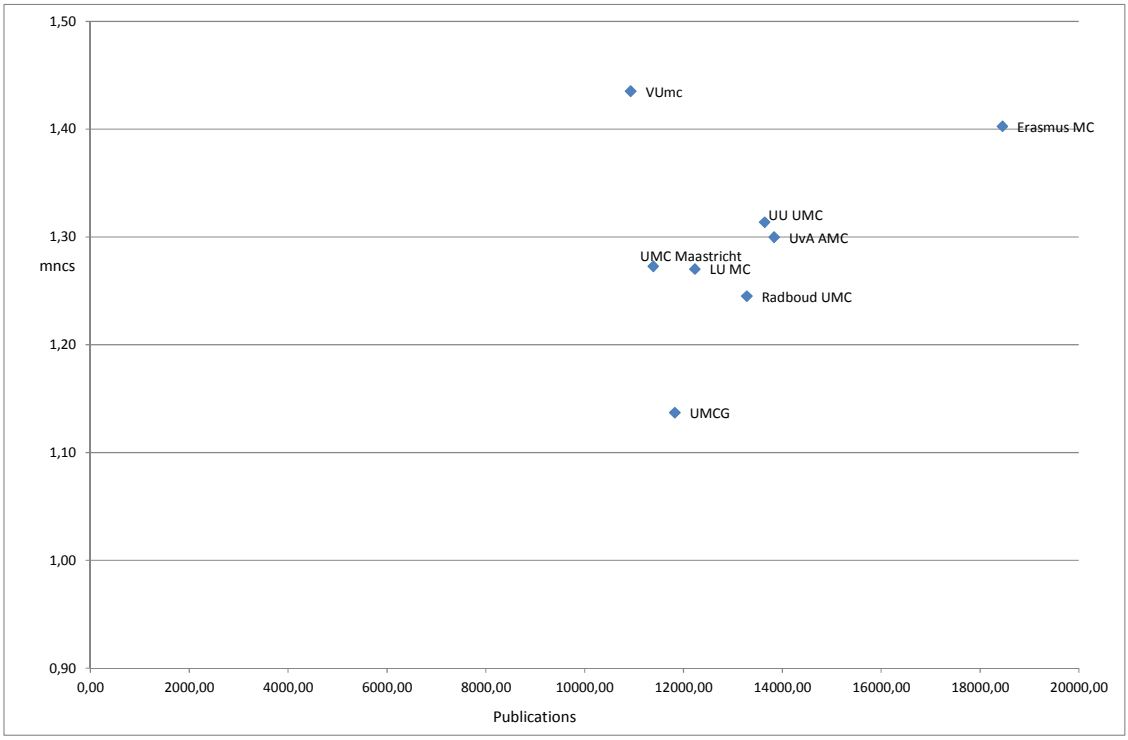


Figure 14b: Output compared to field-normalized impact (MNCS), first authorships only, 2010-2014/2015

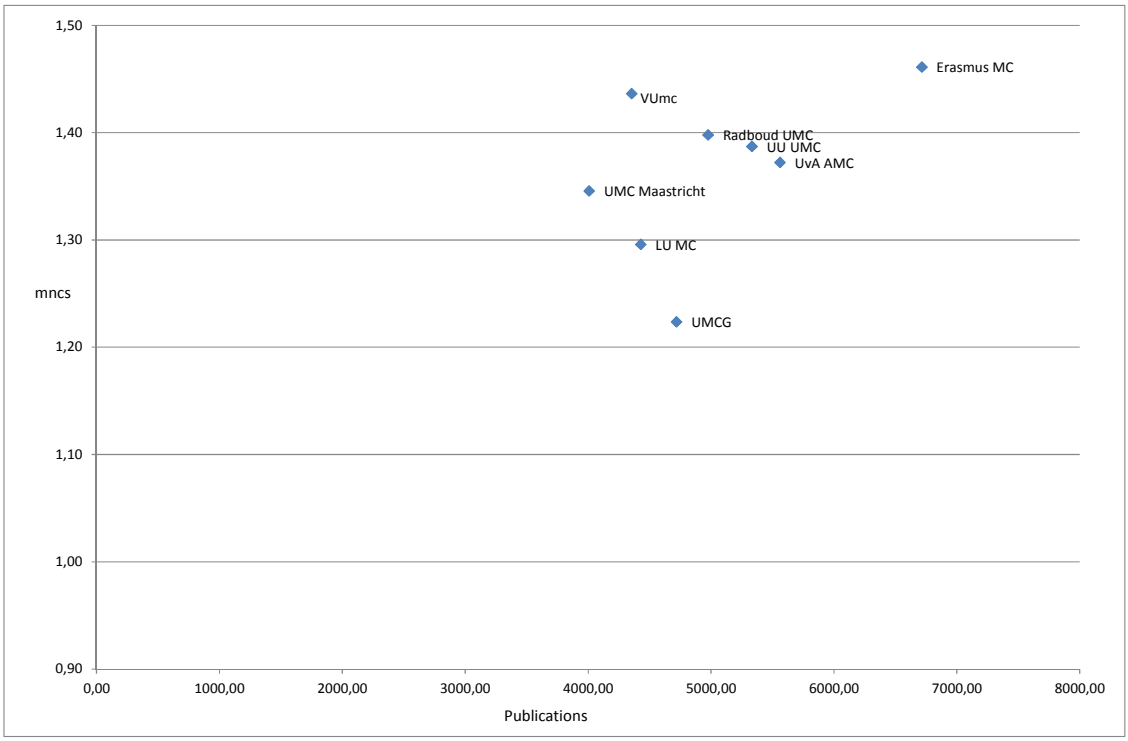


Figure 15: Trend analysis of the field-normalized impact (MNCS) for all Dutch UMCS (first authorship output), 1998-2014/2015

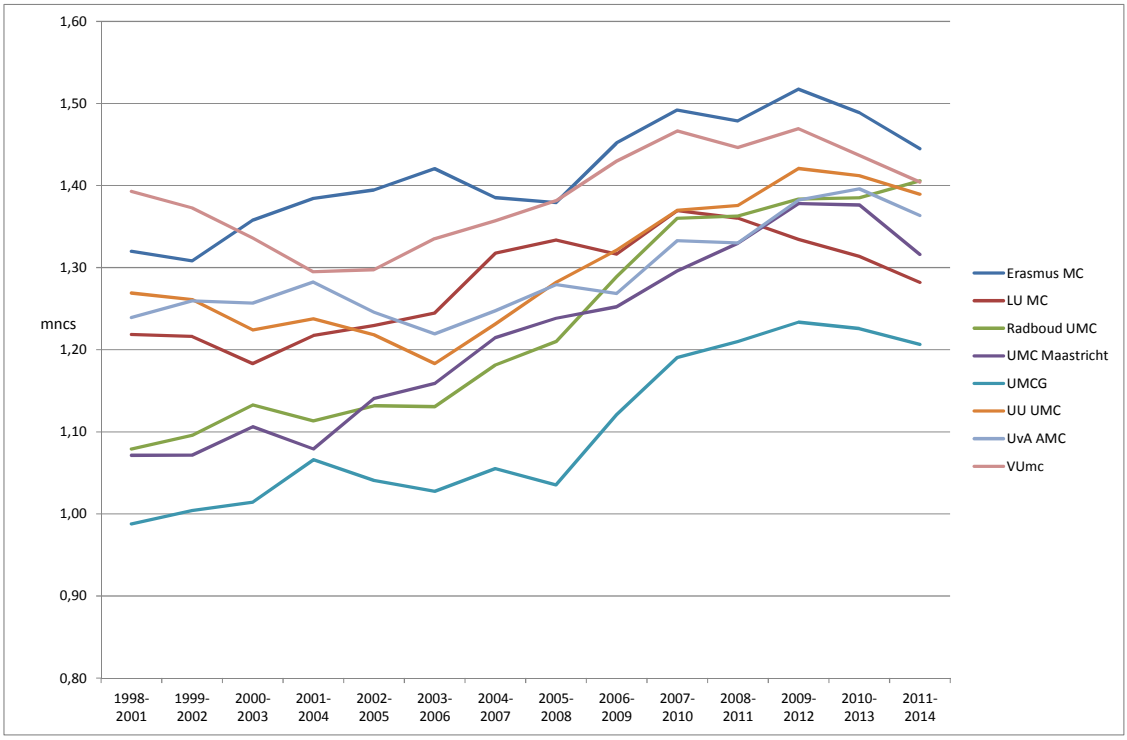


Figure 16a: Output compared to field-normalized impact (MNCS), international cooperation only, 1998-2014/2015

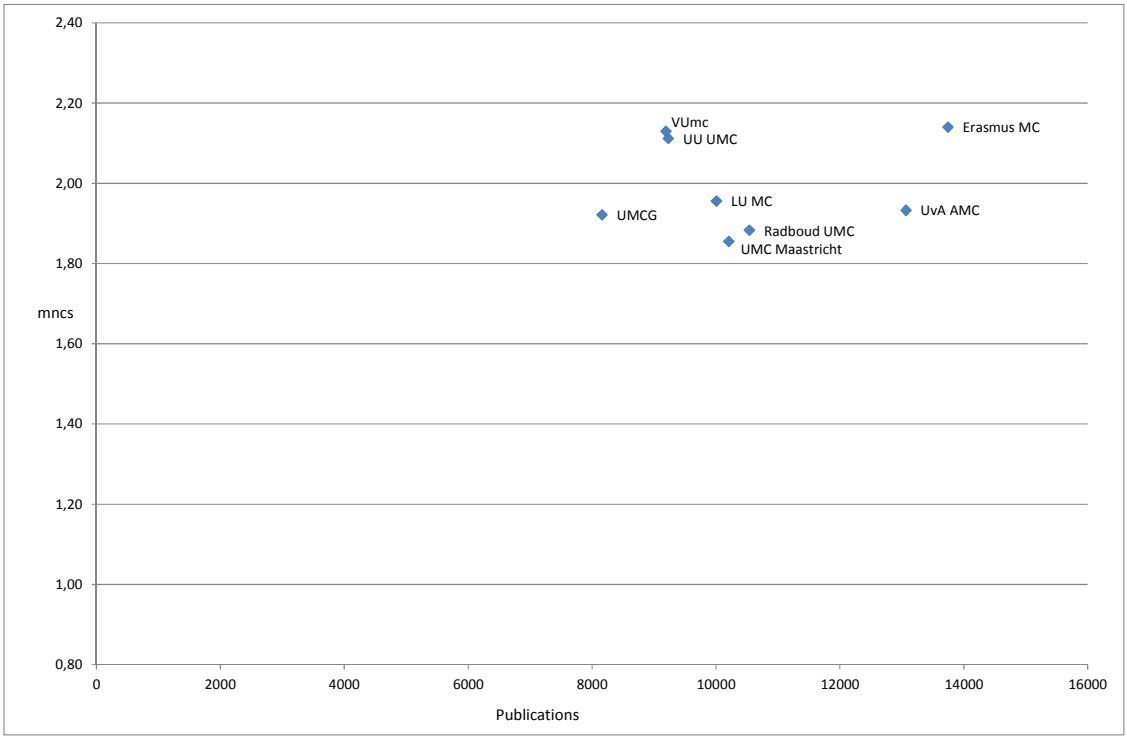


Figure 16b: Output compared to field-normalized impact (MNCS), international cooperation only, 2010-2014/2015

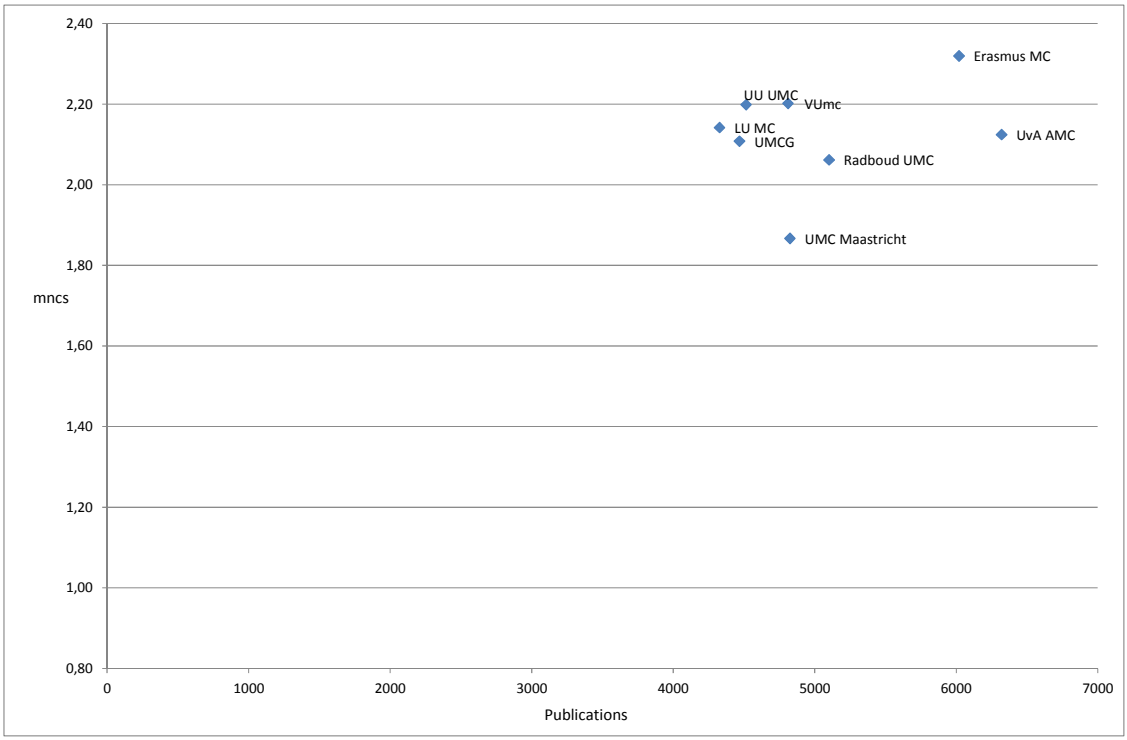


Figure 17: Trend analysis of the field-normalized impact (MNCS) for all Dutch UMCS (international cooperation output), 1998-2014/2015

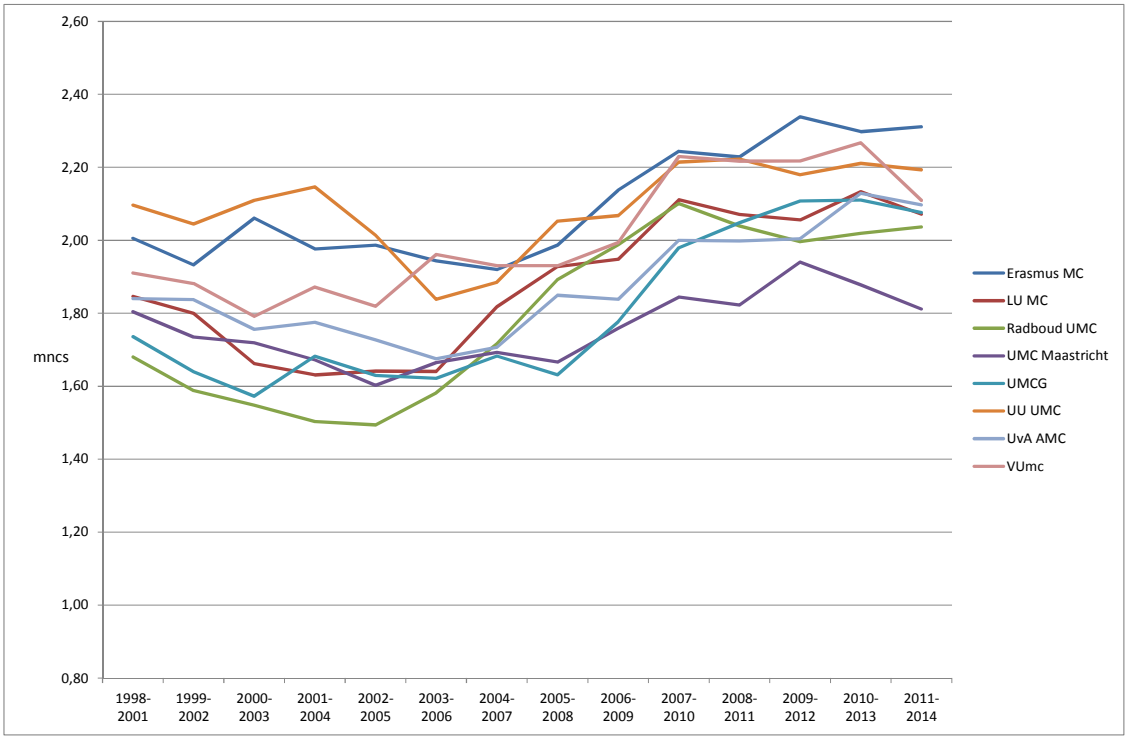


Figure 18a: Output compared to field-normalized impact (MNCS), single institute only, 1998-2014/2015

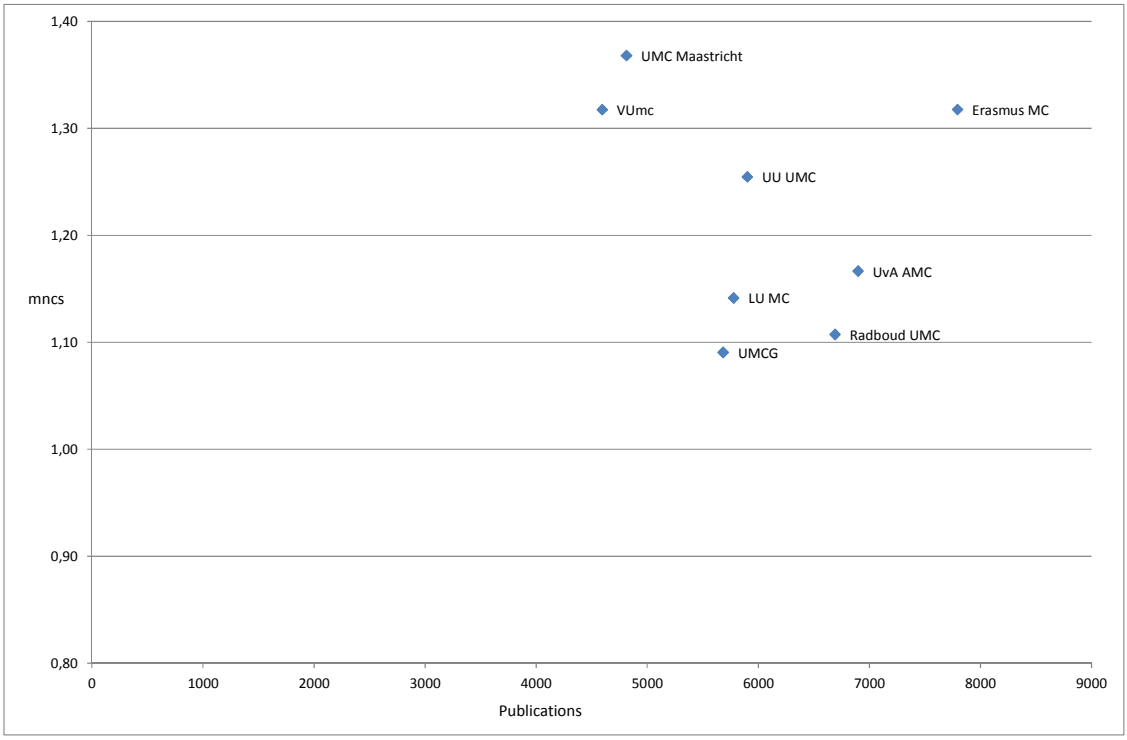


Figure 18b: Output compared to field-normalized impact (MNCS), single institute only, 2010-2014/2015

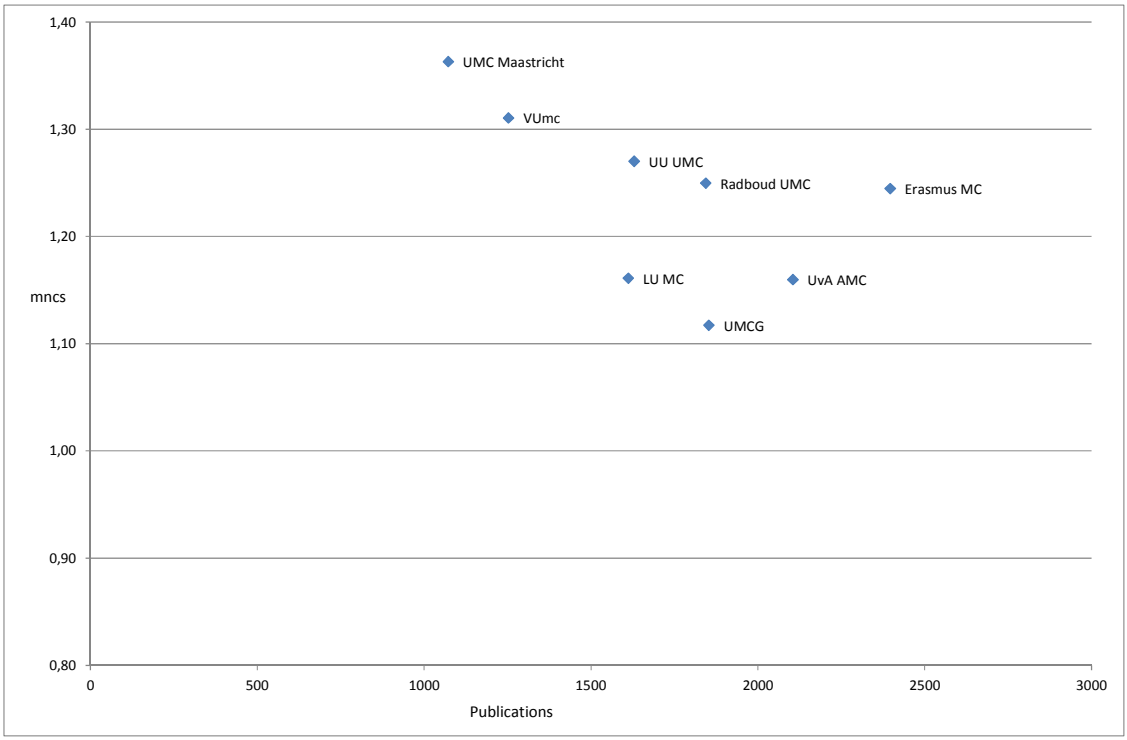
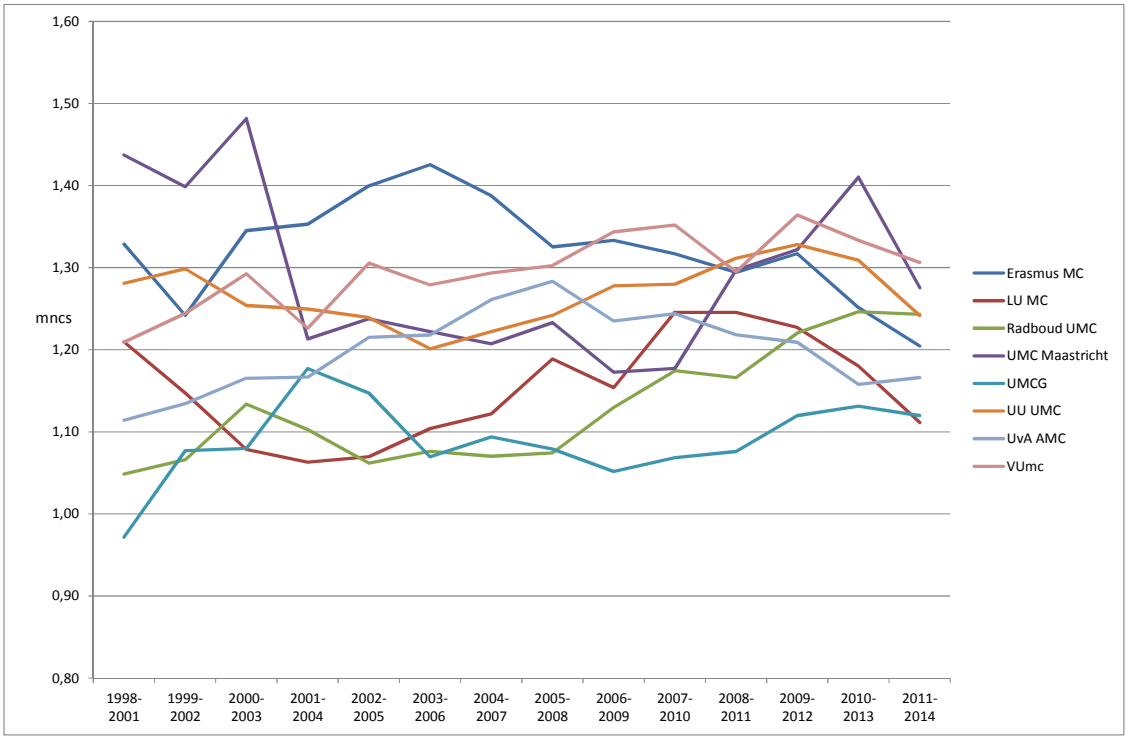


Figure 19: Trend analysis of the field-normalized impact (MNCS) for all Dutch UMCS (single institute output), 1998-2014/2015



2.4 Analysis of top-research

Per medical center, a break-down into different classes of journal impact is made. While the data in Table 1 show the overall situation, Table 5 contains the results of an analysis when the publications from each medical center are analyzed according to the journal-to-field impact classes that the publications can be counted in.

We distinguish five classes, the first class is the set of publications where the ***MNJS*** of the journal is ranging between 0.00 and 0.40 (Class A), the second class is ranging from 0.41 to 0.80 (Class B), the third class is ranging from 0.81 to 1.20 (Class C), the fourth class ranges from 1.21 to 1.60 (Class D), while finally the fifth class contains all publications in journals with a higher ***MNJS*** value as 1.61 (Class E).

Table 5a: Distribution of output of Dutch academic medical centers over journal impact classes, 1998-2014/2015

		P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
Erasmus MC	A	1546,75	12662,50	8,19	0,33	0,28	1%	17%	18%	88%
Erasmus MC	B	6903,50	103227,25	14,95	0,72	0,63	5%	7%	18%	89%
Erasmus MC	C	9638,50	199218,75	20,67	1,10	0,99	11%	5%	18%	89%
Erasmus MC	D	5913,50	180550,00	30,53	1,65	1,38	19%	3%	17%	89%
Erasmus MC	E	8336,00	556874,50	66,80	3,31	2,82	40%	2%	15%	91%
LU MC	A	1243,50	10183,25	8,19	0,32	0,27	1%	18%	19%	89%
LU MC	B	5267,75	85024,00	16,14	0,73	0,63	5%	7%	18%	91%
LU MC	C	7154,00	160011,00	22,37	1,15	0,99	11%	5%	18%	92%
LU MC	D	4000,25	107547,00	26,89	1,41	1,37	17%	3%	18%	92%
LU MC	E	5906,75	361799,75	61,25	3,01	2,76	38%	1%	16%	93%
Radboud UMC	A	1291,75	11478,50	8,89	0,33	0,28	1%	14%	17%	88%
Radboud UMC	B	5903,25	82839,25	14,03	0,69	0,63	4%	8%	17%	89%
Radboud UMC	C	7501,25	141599,00	18,88	1,07	0,99	11%	5%	18%	89%
Radboud UMC	D	4368,25	115174,50	26,37	1,52	1,38	18%	3%	16%	90%
Radboud UMC	E	5762,25	304603,50	52,86	3,00	2,70	38%	2%	16%	91%
UMC Maastricht	A	1220,50	10075,25	8,26	0,34	0,27	1%	19%	19%	84%
UMC Maastricht	B	5143,75	77493,25	15,07	0,73	0,63	5%	8%	17%	86%
UMC Maastricht	C	7008,50	146495,25	20,90	1,15	0,99	11%	5%	17%	87%
UMC Maastricht	D	4140,50	118957,25	28,73	1,56	1,37	19%	3%	16%	87%
UMC Maastricht	E	5035,25	309273,75	61,42	3,19	2,54	37%	2%	14%	88%

		P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
UMCG	A	1178,50	8174,75	6,94	0,30	0,27	1%	21%	18%	87%
UMCG	B	4784,75	62456,00	13,05	0,70	0,63	5%	9%	17%	89%
UMCG	C	6623,75	115866,00	17,49	1,03	0,99	10%	6%	17%	89%
UMCG	D	3993,75	91055,50	22,80	1,43	1,37	17%	5%	16%	89%
UMCG	E	5252,50	257177,50	48,96	2,91	2,74	37%	2%	17%	91%
UU UMC	A	931,00	7717,00	8,29	0,35	0,28	1%	15%	16%	89%
UU UMC	B	5327,50	79489,50	14,92	0,71	0,63	5%	7%	16%	91%
UU UMC	C	7353,75	153347,00	20,85	1,09	0,99	11%	5%	16%	91%
UU UMC	D	4571,25	130056,75	28,45	1,54	1,38	18%	4%	15%	91%
UU UMC	E	6541,00	394958,00	60,38	3,06	2,78	39%	1%	14%	92%
UvA AMC	A	1828,75	14498,25	7,93	0,32	0,28	1%	19%	19%	88%
UvA AMC	B	7388,50	105014,25	14,21	0,71	0,62	5%	9%	17%	89%
UvA AMC	C	9158,25	181025,25	19,77	1,08	0,99	10%	6%	17%	90%
UvA AMC	D	5664,75	158732,75	28,02	1,53	1,37	19%	4%	17%	90%
UvA AMC	E	7294,75	408860,75	56,05	3,14	2,82	38%	2%	15%	91%
VUmc	A	999,75	8081,50	8,08	0,35	0,28	1%	20%	19%	88%
VUmc	B	4852,25	71445,50	14,72	0,75	0,63	5%	9%	17%	88%
VUmc	C	7055,75	145370,00	20,60	1,17	0,99	12%	5%	17%	89%
VUmc	D	4080,25	122253,50	29,96	1,65	1,37	20%	4%	16%	89%
VUmc	E	5417,75	342540,75	63,23	3,38	2,67	42%	2%	15%	91%

Table 5b: Distribution of output of Dutch academic medical centers over journal impact classes, 2010-2014/2015

		P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
Erasmus MC	A	377,25	1056,25	2,80	0,34	0,29	1%	32%	22%	86%
Erasmus MC	B	2327,25	13987,25	6,01	0,76	0,64	5%	15%	22%	88%
Erasmus MC	C	3899,00	35117,50	9,01	1,13	1,00	12%	9%	22%	89%
Erasmus MC	D	2360,75	28522,00	12,08	1,62	1,38	19%	7%	22%	89%
Erasmus MC	E	3527,25	106570,50	30,21	3,42	2,97	42%	3%	21%	92%
LU MC	A	282,50	941,50	3,33	0,36	0,29	2%	34%	29%	90%
LU MC	B	1737,25	12298,75	7,08	0,76	0,64	5%	13%	21%	91%
LU MC	C	3009,75	30732,50	10,21	1,15	1,00	12%	9%	22%	92%
LU MC	D	1563,75	18792,00	12,02	1,49	1,38	19%	6%	21%	92%
LU MC	E	2397,75	74157,00	30,93	3,22	2,98	41%	2%	23%	93%
Radboud UMC	A	295,00	999,00	3,39	0,37	0,30	1%	29%	25%	89%
Radboud UMC	B	2142,50	11874,00	5,54	0,68	0,64	4%	17%	23%	89%
Radboud UMC	C	3164,50	27575,00	8,71	1,12	0,99	11%	9%	22%	90%
Radboud UMC	D	1796,00	19914,50	11,09	1,53	1,38	19%	6%	22%	90%
Radboud UMC	E	2694,50	76048,50	28,22	3,32	2,85	42%	4%	21%	92%
UMC Maastricht	A	343,50	1026,00	2,99	0,35	0,30	1%	36%	27%	83%
UMC Maastricht	B	1822,00	10221,25	5,61	0,71	0,64	5%	19%	22%	87%
UMC Maastricht	C	2931,50	26751,25	9,13	1,15	1,00	11%	9%	22%	88%
UMC Maastricht	D	1589,00	17767,50	11,18	1,52	1,36	19%	7%	22%	88%
UMC Maastricht	E	2068,00	56251,00	27,20	3,25	2,70	40%	4%	20%	89%

		P	TCS	MCS	MNCS	MNJS	PP(top 10%)	PP(uncited)	%Self Cit	Int Cov
UMCG	A	330,50	875,00	2,65	0,31	0,29	1%	40%	25%	86%
UMCG	B	1903,50	10560,25	5,55	0,72	0,64	5%	16%	20%	89%
UMCG	C	3179,75	26158,00	8,23	1,03	1,00	10%	11%	22%	90%
UMCG	D	1871,00	19868,25	10,62	1,48	1,37	18%	8%	21%	90%
UMCG	E	2636,75	72436,25	27,47	3,17	2,95	39%	4%	22%	92%
UU UMC	A	274,50	1076,50	3,92	0,41	0,30	2%	27%	20%	91%
UU UMC	B	1880,75	11305,75	6,01	0,73	0,64	5%	14%	21%	91%
UU UMC	C	3164,25	28244,25	8,93	1,05	1,00	10%	10%	22%	92%
UU UMC	D	1899,50	23167,75	12,20	1,58	1,38	19%	7%	21%	92%
UU UMC	E	2875,25	83550,25	29,06	3,23	2,97	42%	2%	20%	93%
UvA AMC	A	560,75	1592,00	2,84	0,32	0,28	1%	34%	24%	89%
UvA AMC	B	2863,75	17275,25	6,03	0,72	0,63	5%	16%	22%	89%
UvA AMC	C	4267,25	35980,00	8,43	1,04	1,00	10%	10%	22%	90%
UvA AMC	D	2308,50	26700,50	11,57	1,51	1,37	19%	7%	22%	90%
UvA AMC	E	3371,00	100325,75	29,76	3,45	3,02	41%	4%	19%	92%
VUmc	A	368,75	1079,25	2,93	0,36	0,28	2%	36%	28%	87%
VUmc	B	2111,00	12242,50	5,80	0,75	0,64	5%	18%	23%	87%
VUmc	C	3380,25	31281,25	9,25	1,18	0,99	12%	9%	22%	89%
VUmc	D	1806,25	21497,50	11,90	1,56	1,37	19%	7%	22%	89%
VUmc	E	2605,25	82990,25	31,86	3,55	2,82	42%	4%	21%	91%

Another method of showing the distribution over the five classes is shown in **Figures 20a** and **20b**. While **Figure 20a** contains the alphabetical representation of the medical centers, the data in **Figure 20b** are sorted by descending share in the two highest classes (thus containing all publications in journals with a ***MNJS*** value higher than 1.20). Additional graph **20c** displays the level of the impact (***MNCS*** scores) for each of the academic medical centers, to provide an impression of the average effect of the publishing across various classes of journal impact.

Similar analyses are conducted for the more recent period 2010-2014/2015, resulting in consecutive graphs **Figure 21a** (displaying the alphabetical; order of the UMC's and the distribution of output over classes of MNJS values), **Figure 21b**, which displays the ordered UMC's, by grouping the two highest MNJS-value classes, and finally **Figure 21c**, which displays the actual impact scores related to the distribution of output over MNJS-classes.

Figure 20a: Distribution of output over journal-to-field impact classes (MNJS), 1998-2014/2015

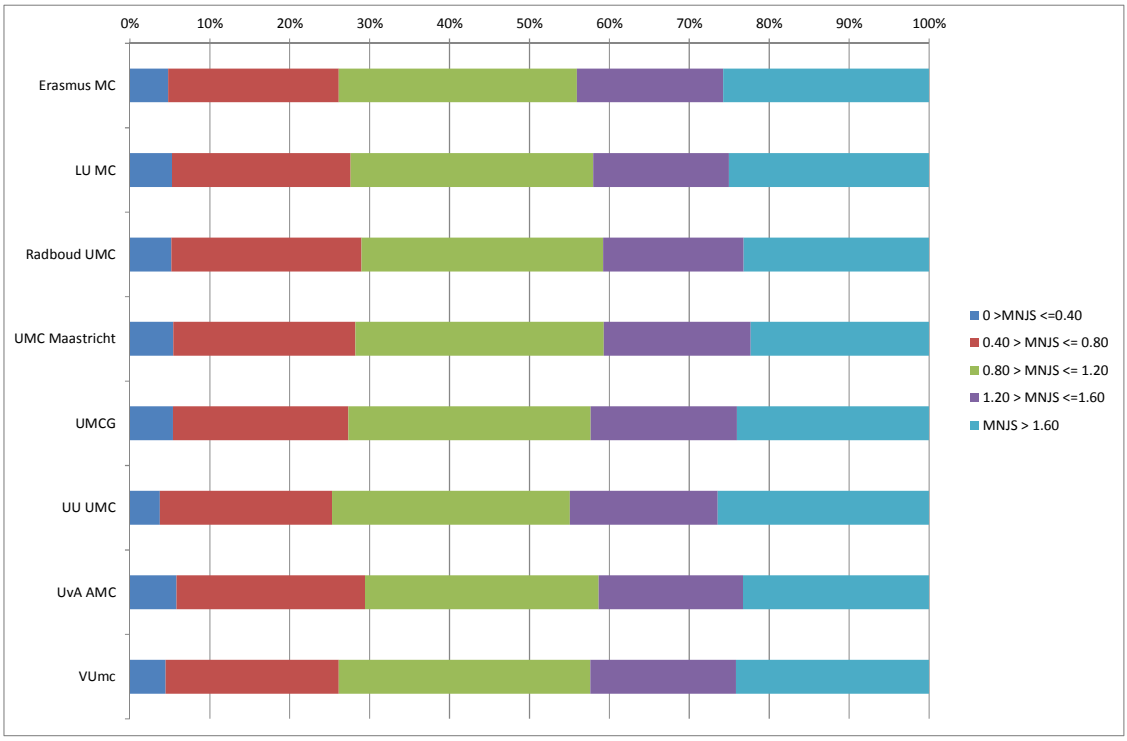


Figure 20b: Distribution of output over journal-to-field impact classes (by descending highest share in the two classes MNJS > 1.20), 1998-2014/2015

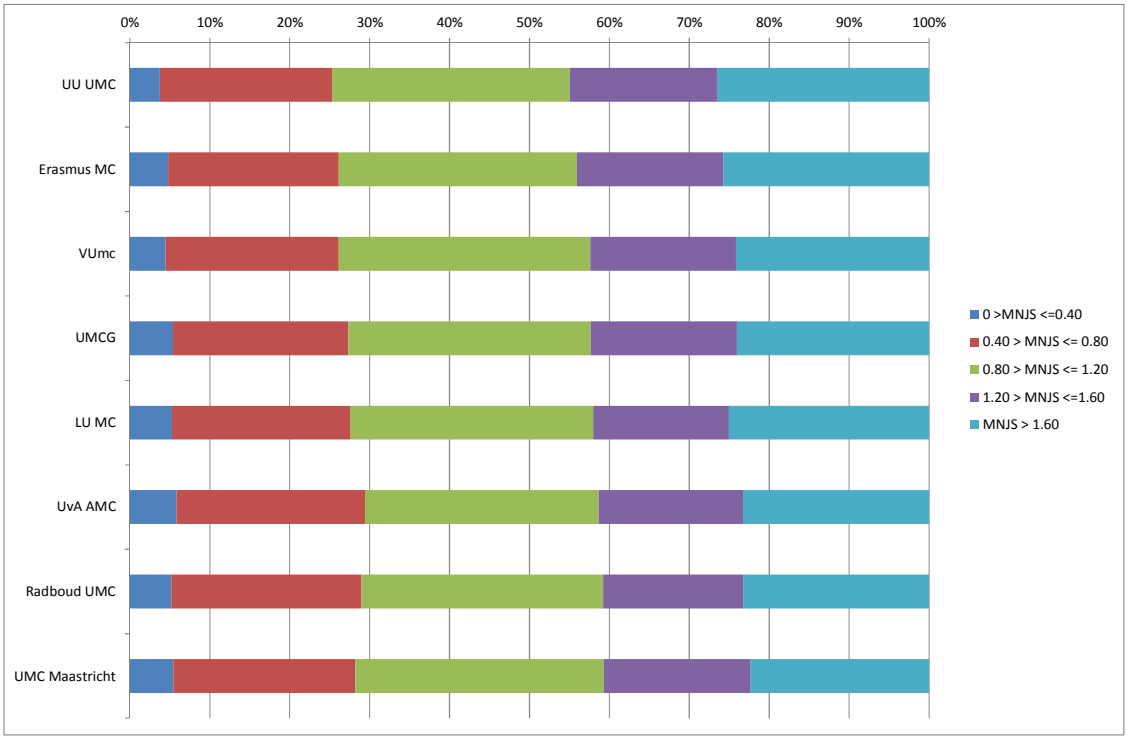


Figure 20c: Impact level (MNCS) of output over journal-to-field impact classes, 1998-2014/2015

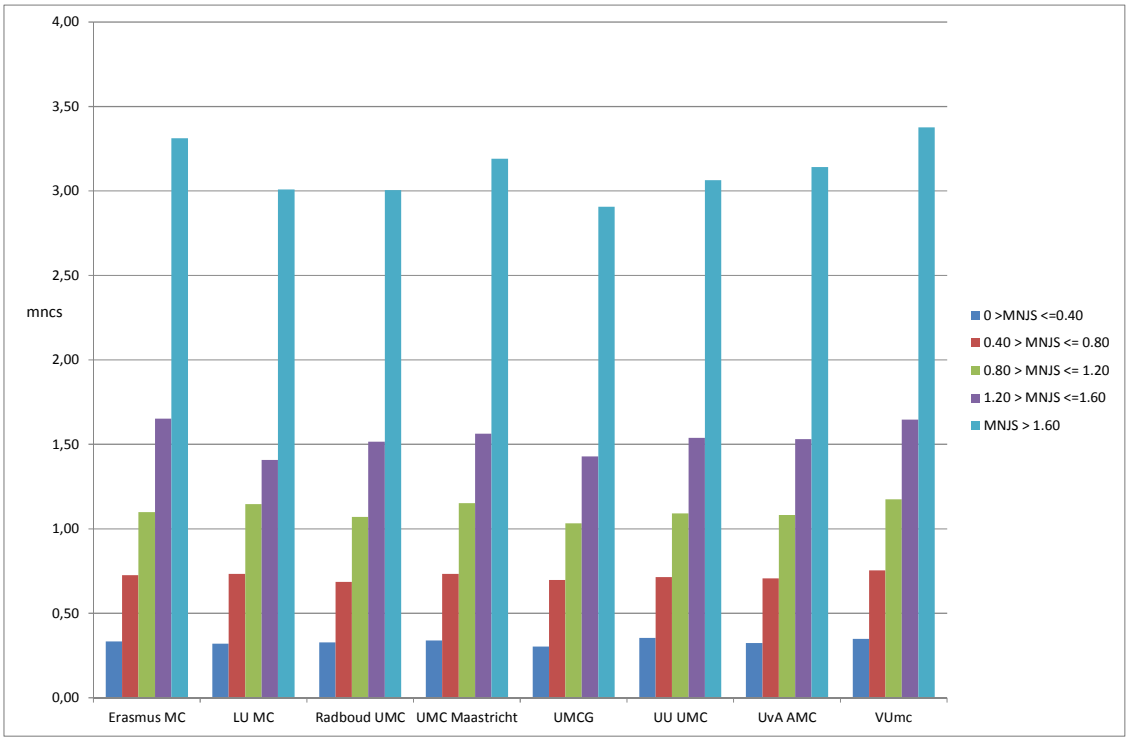


Figure 21a: Distribution of output over journal-to-field impact classes (MNJS), 2010-2014/2015

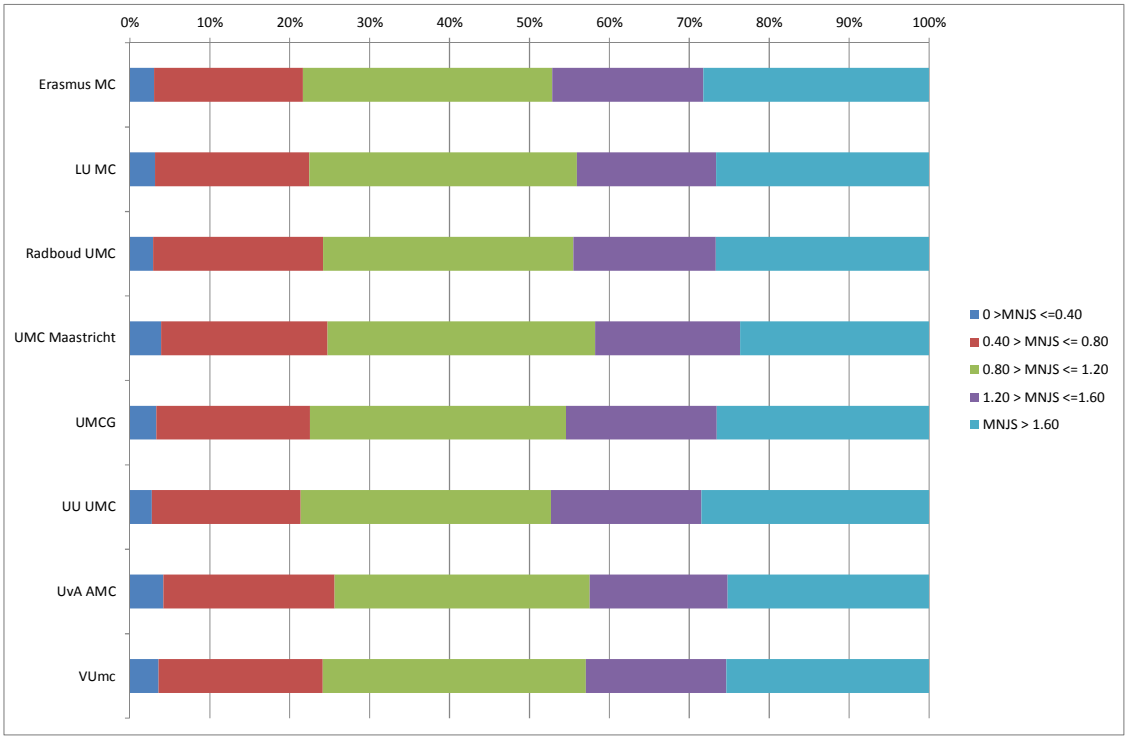


Figure 21b: Distribution of output over journal-to-field impact classes (by descending highest share in the two classes MNJS > 1.20), 2010-2014/2015

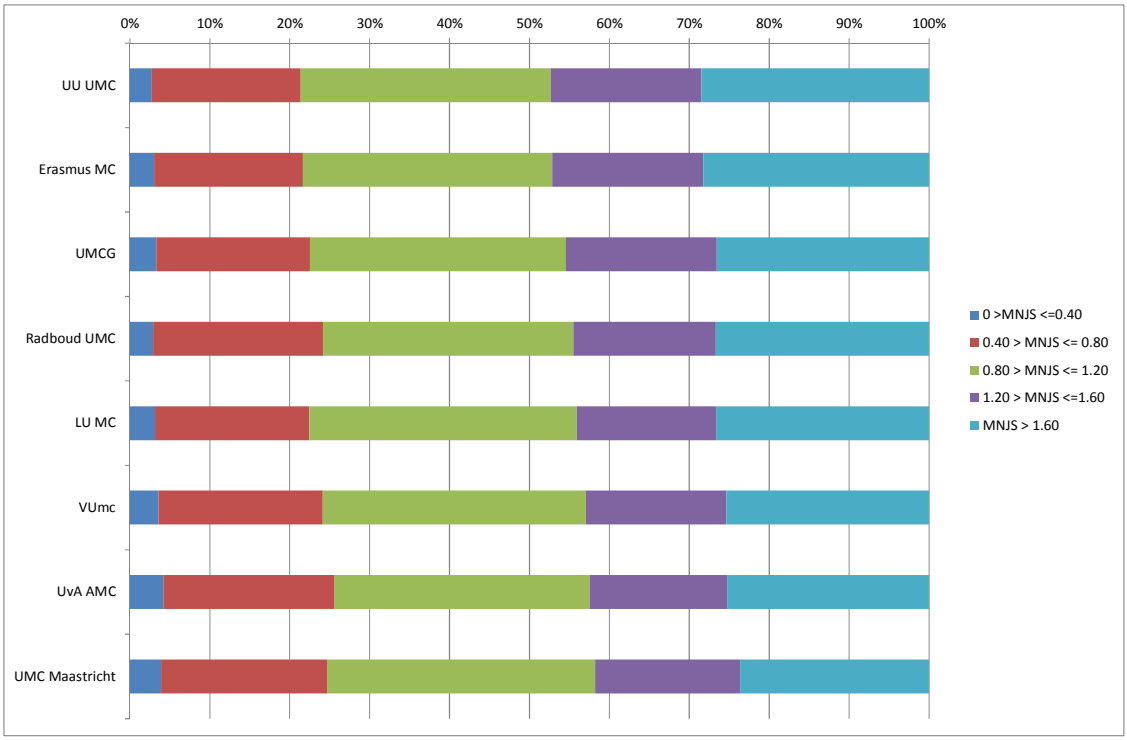
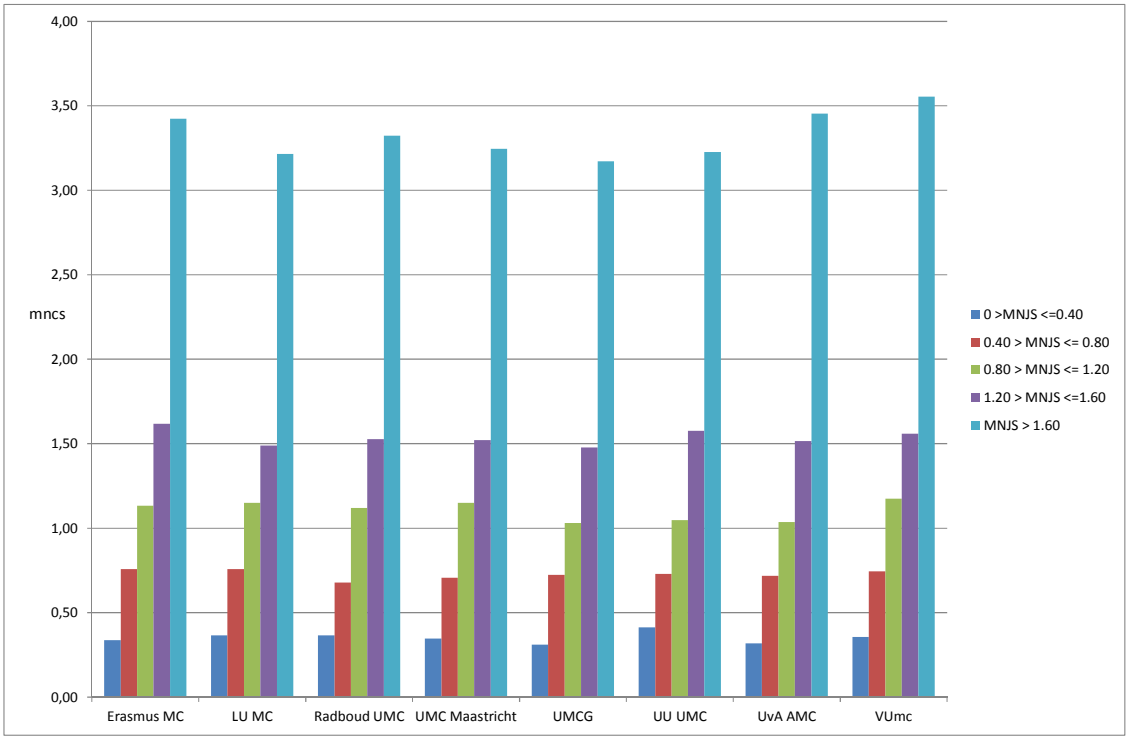


Figure 21c: Impact level (MNCS) of output over journal-to-field impact classes, 2010-2014/2015



A clear difference between publishing in top medical journals and top multidisciplinary research journals is shown in **Figures 22** and **23**. The figures also show that there is a clear difference in the way these publications are received, citation wise, in particular for the papers publication in the general medicine category.

In **Figure 22**, the results are shown of publications in four general medicine journals, with a multidisciplinary medical content, **The Lancet, JAMA, the New England Journal of Medicine**, and the **British Journal of Medicine**.

The graph compares the average impact of all output (mcs All) with the average impact of the respective UMCs in these four general medicine top journals (mcs GMJ). Next to this, the share of the output in these four journals as share of the total output of the respective UMCs is expressed as a percentage of the total output.

Figure 23 contains a similar analysis, in this case focusing on four general multidisciplinary journals: **Science**, **Nature**, and **PLOS-One** and the **Proceedings of the National Academy of Sciences of the USA**. As in Figure 22, in Figure 23 we present the average impact (mcs MDJ) in these four journals with that of the total output of the respective UMCs (mcs All), again in combination with the percentage of the total output that appeared in these four multidisciplinary top journals.

Figure 22: Comparing mean citation score (mcs All) and output shares in four general medicine top journals (mcs GMJ), 2010-2014/2015

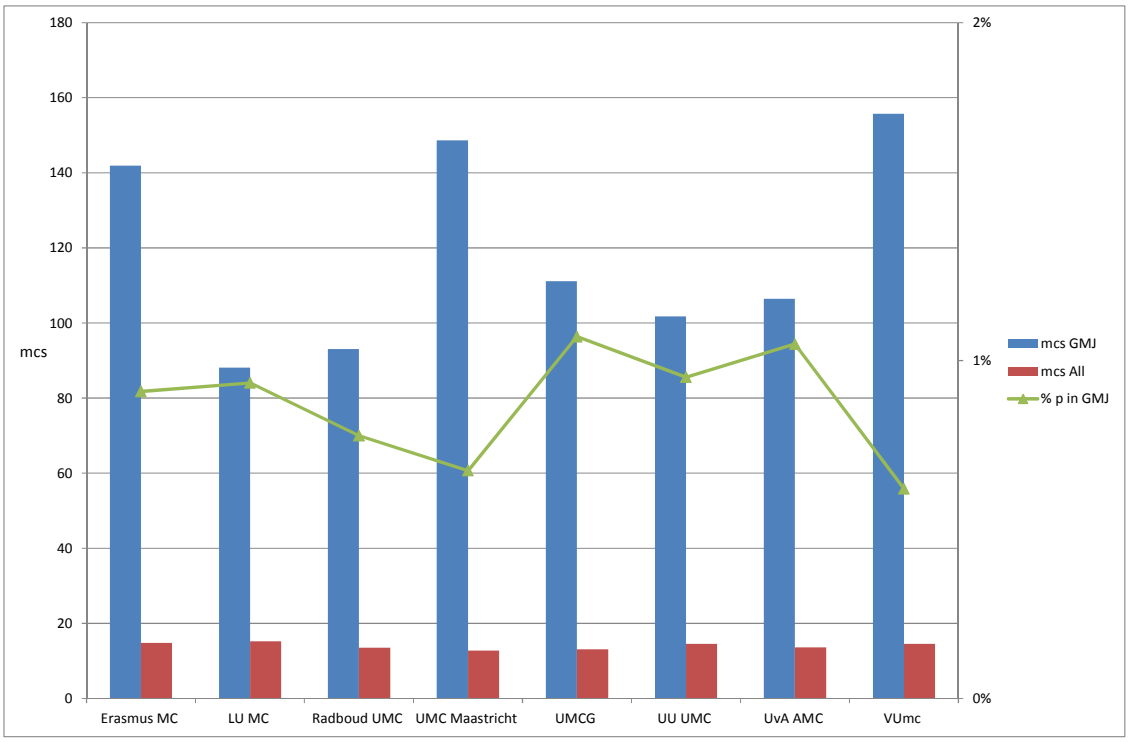
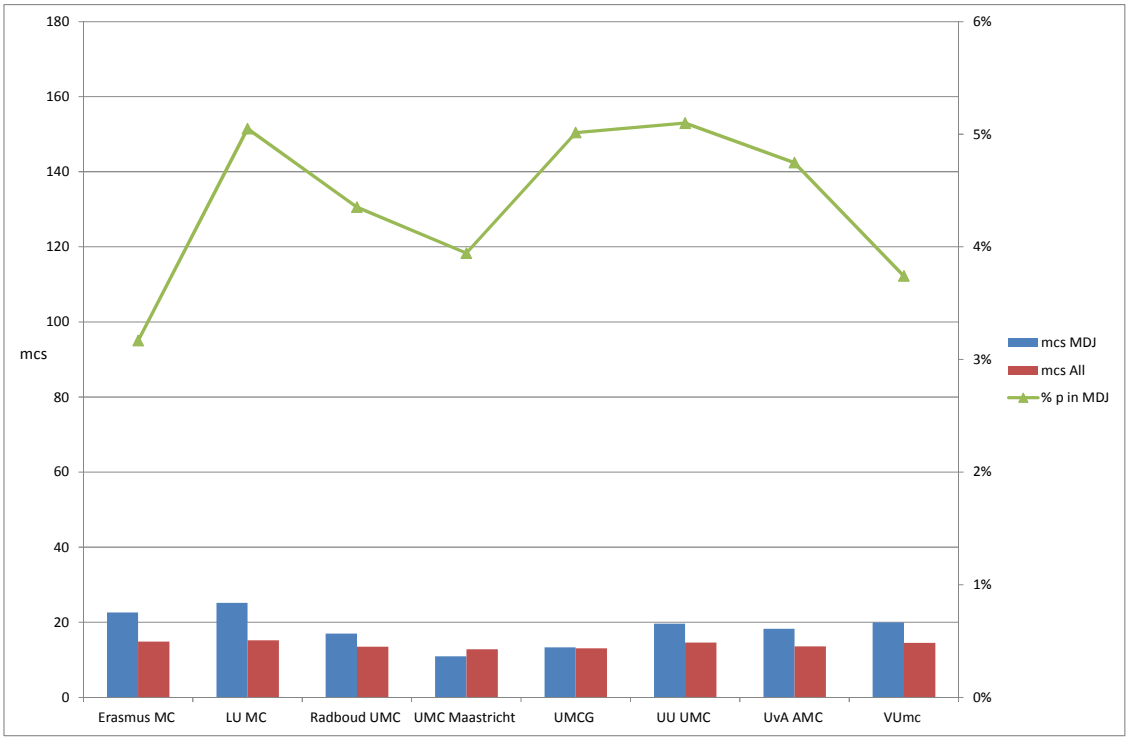


Figure 23: Comparing mean citation score (mcs All) and output shares in four general multidisciplinary top journals (mcs MDJ), 2010-2014/2015

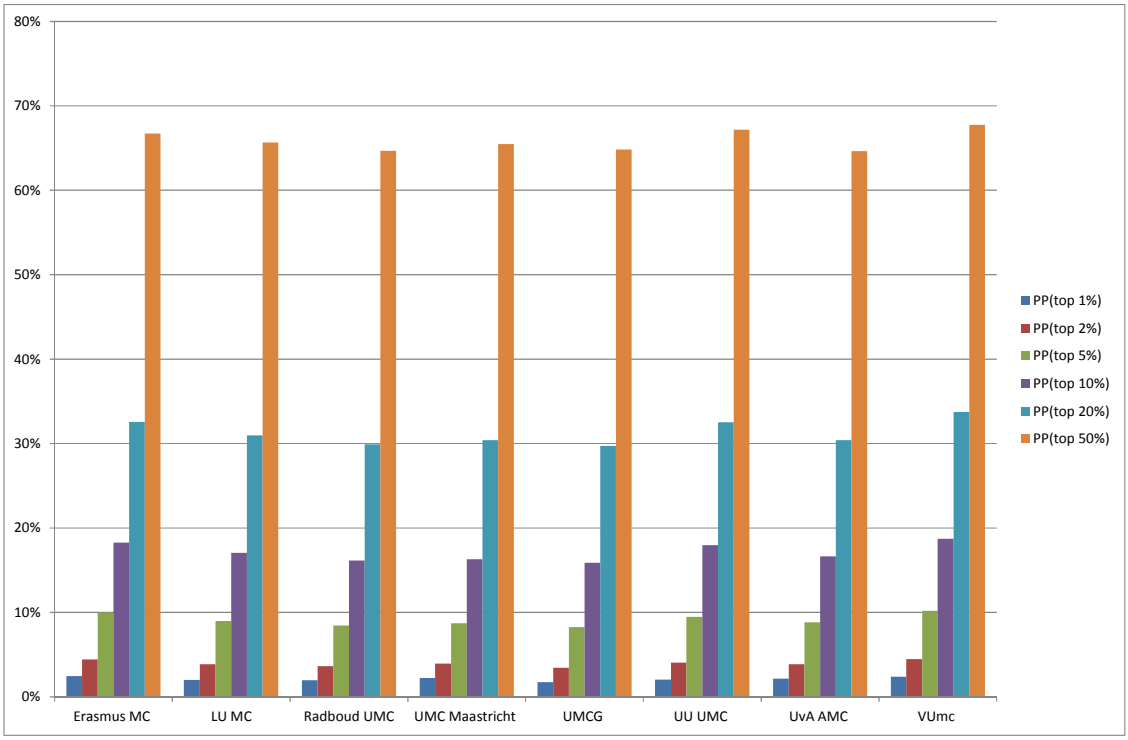


A third bibliometric approach of scientific top research or excellence is shown in Table 6 and **Figure 24**. As indicated before, the top paper analysis can be extended to other parts of the total publications set, and accordingly, other parts of the distribution of impact over publications. Here we present the presence of Dutch academic medical centers among respectively the top-50%, top-20%, the top-10%, the top-5%, the top-2% and the top-1% most highly cited publications in the fields these centers are active in. In Table 6, we present the output that relates to the actual numbers of publications per UMC within the various sub-sets of the total distribution most highly cited publications in the fields these centers are active in, while **Figure 24** displays these relative outcomes for the eight Dutch academic medical centers graphically.

Table 6: Overview of the presence of Dutch academic medical centers in the top-x most highly cited publications, 1998-2014/2015

	p 1998-2014	P in Top 1%	PP(top 1%)	P in Top 2%	PP(top 2%)	P in Top 5%	PP(top 5%)	P in Top 10%	PP(top 10%)	P in Top 20%	PP(top 20%)	P in Top 50%	PP(top 50%)
Erasmus MC	32338,3	791,2	2%	1437,0	4%	3232,2	10%	5915,2	18%	10528,5	33%	21579,8	67%
LU MC	23572,3	472,4	2%	909,1	4%	2117,5	9%	4022,8	17%	7300,4	31%	15479,4	66%
Radboud UMC	24826,8	483,2	2%	898,2	4%	2094,2	8%	4014,4	16%	7421,6	30%	16061,9	65%
UMC Maastricht	22548,5	503,0	2%	887,8	4%	1969,1	9%	3680,4	16%	6855,3	30%	14764,9	65%
UMCG	21833,3	382,2	2%	755,4	3%	1804,1	8%	3472,7	16%	6488,2	30%	14158,5	65%
UU UMC	24724,5	509,7	2%	1001,4	4%	2346,9	9%	4439,4	18%	8044,8	33%	16612,7	67%
UvA AMC	31335,0	670,2	2%	1210,7	4%	2775,6	9%	5214,1	17%	9531,1	30%	20250,6	65%
VUmc	22405,8	532,7	2%	1005,4	4%	2287,2	10%	4195,4	19%	7560,1	34%	15181,6	68%

Figure 24: Presence of the Dutch academic medical centers in Top-50% / Top-20% / Top-10% / Top-5% / Top-2% and Top-1% most highly cited publications worldwide, 1998-2014/2015



2.5 Analysis of the publication strategy: research profiles with MNJS values

In this section, we focus on the journals in which the output was published across the fields in which the medical centers were active in. These profiles are similar to the research profiles, with this difference that the ***MNJS*** is now used to indicate the impact in the field, not as an indicator of the field impact, but rather as an indicator of the journal impact position in the field. The period analyzed is the period 2010-2014/2015. **Figures 25 through 32** contain such profiles for the eight academic medical centers.

Figure 25: Output and journal impact per field (2010-2014/2015)
Erasmus MC

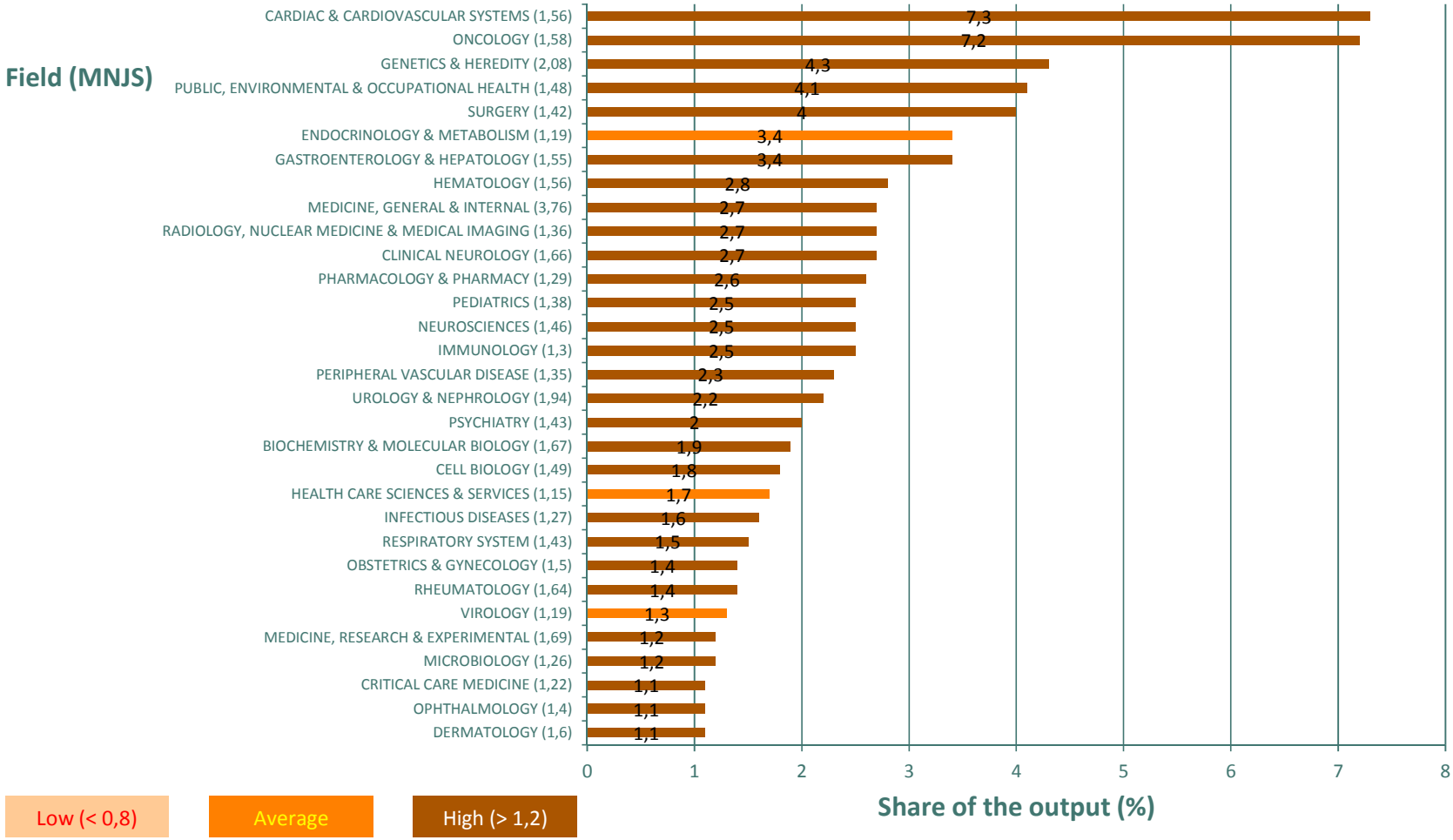


Figure 26: Output and journal impact per field (2010-2014/2015)
LU MC

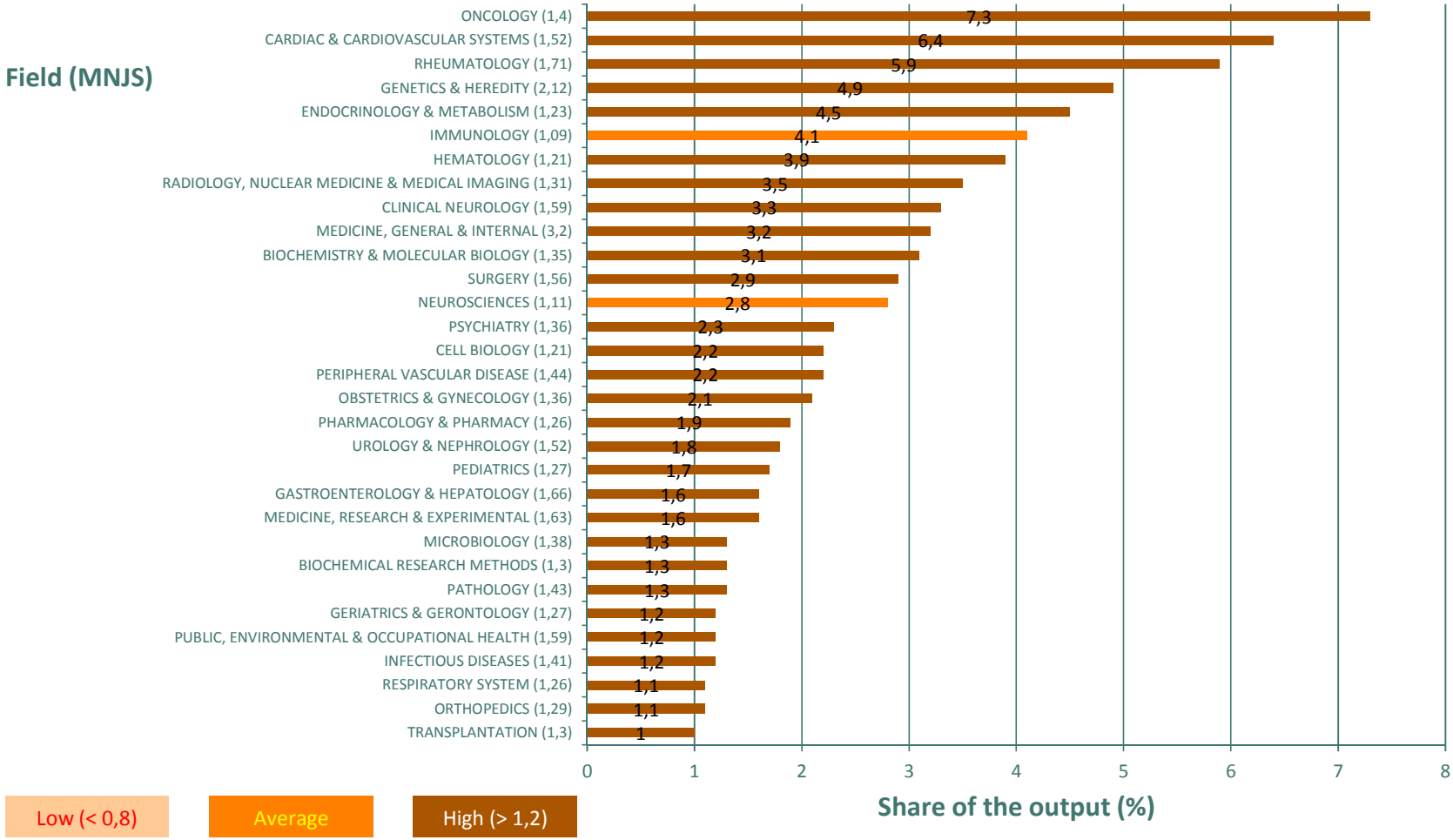


Figure 27: Output and journal impact per field (2010-2014/2015) Radboud UMC

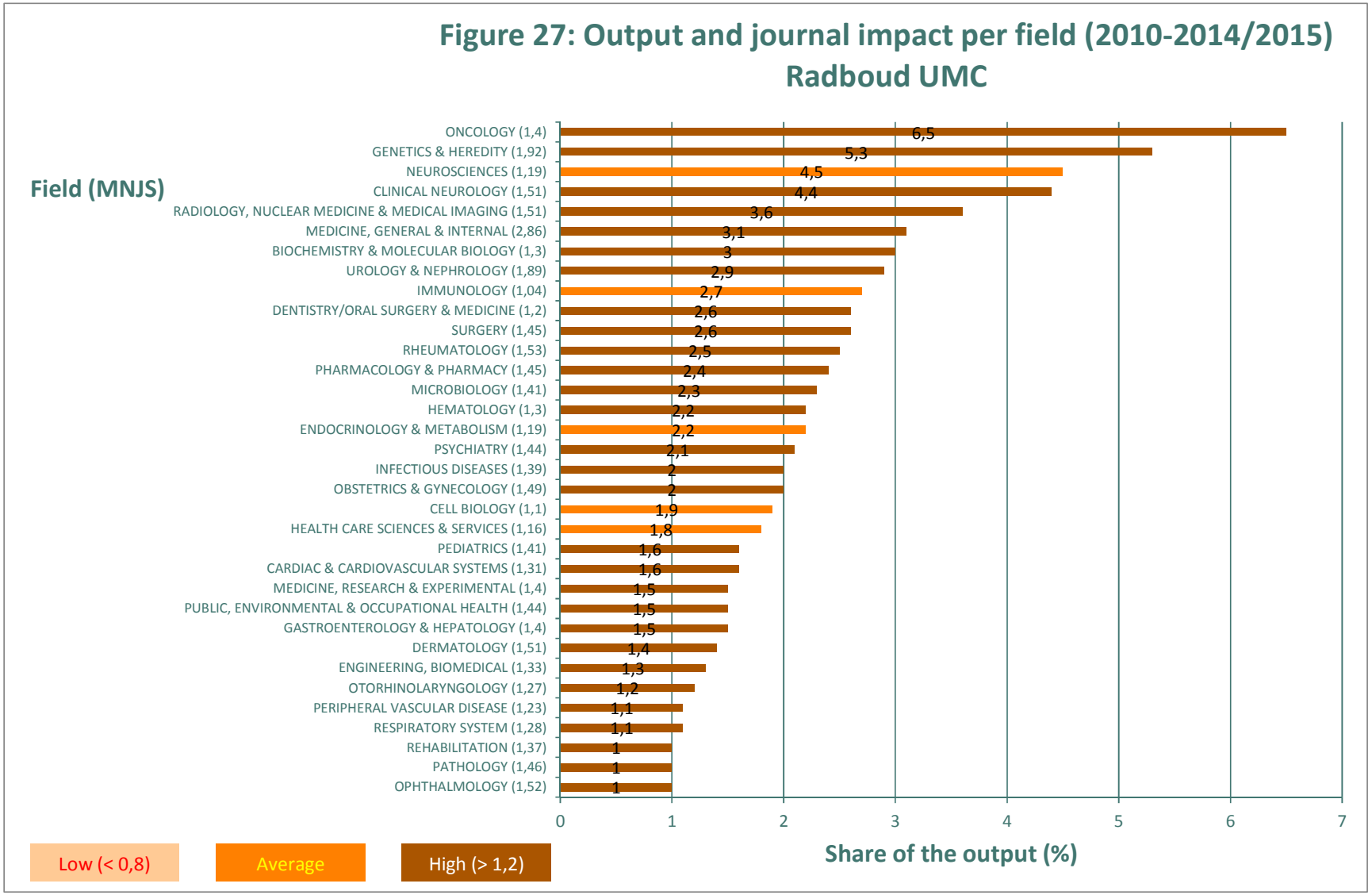


Figure 28: Output and journal impact per field (2010-2014/2015)
UMC Maastricht

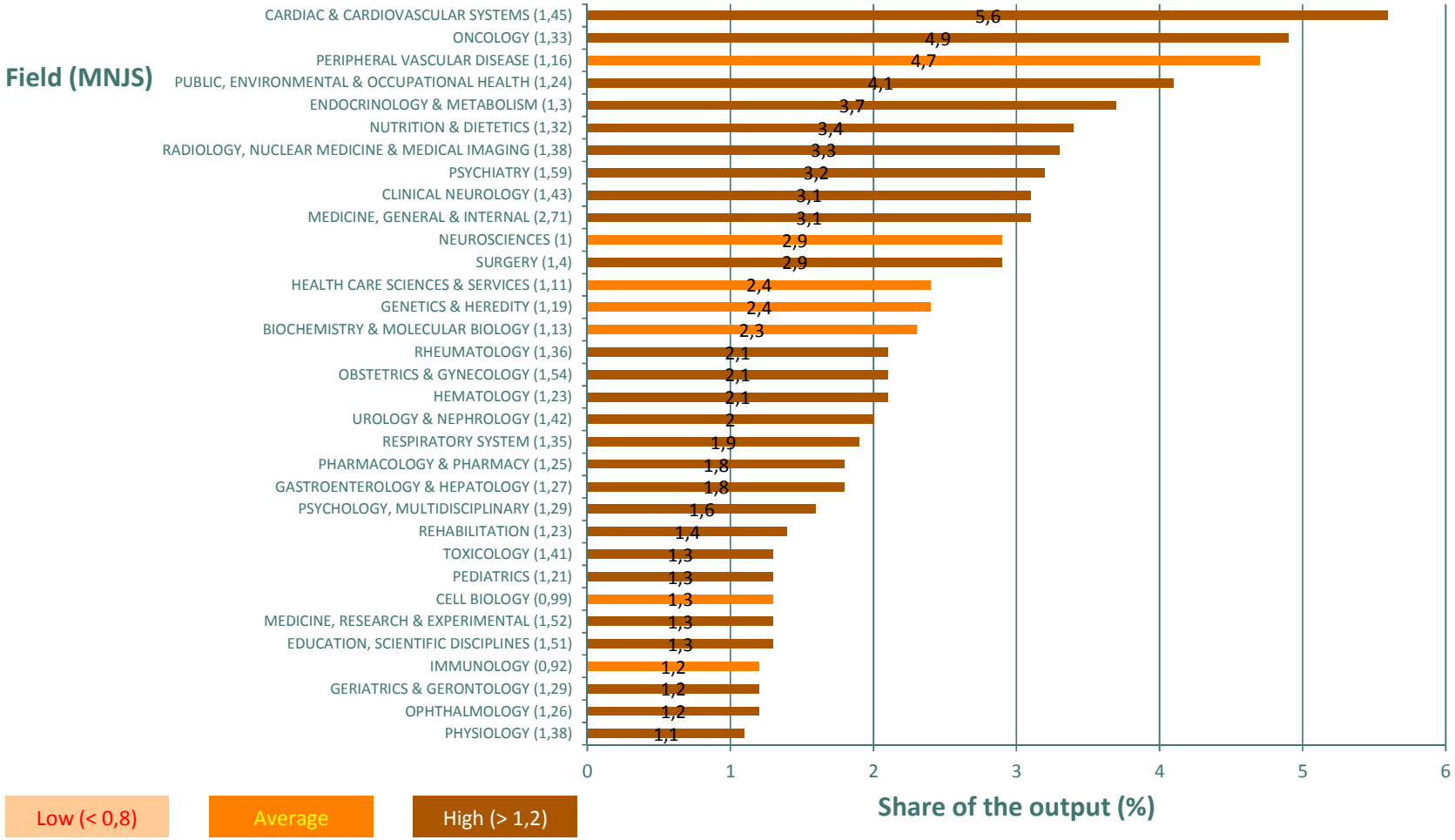


Figure 29: Output and journal impact per field (2010-2014/2015)
UMCG

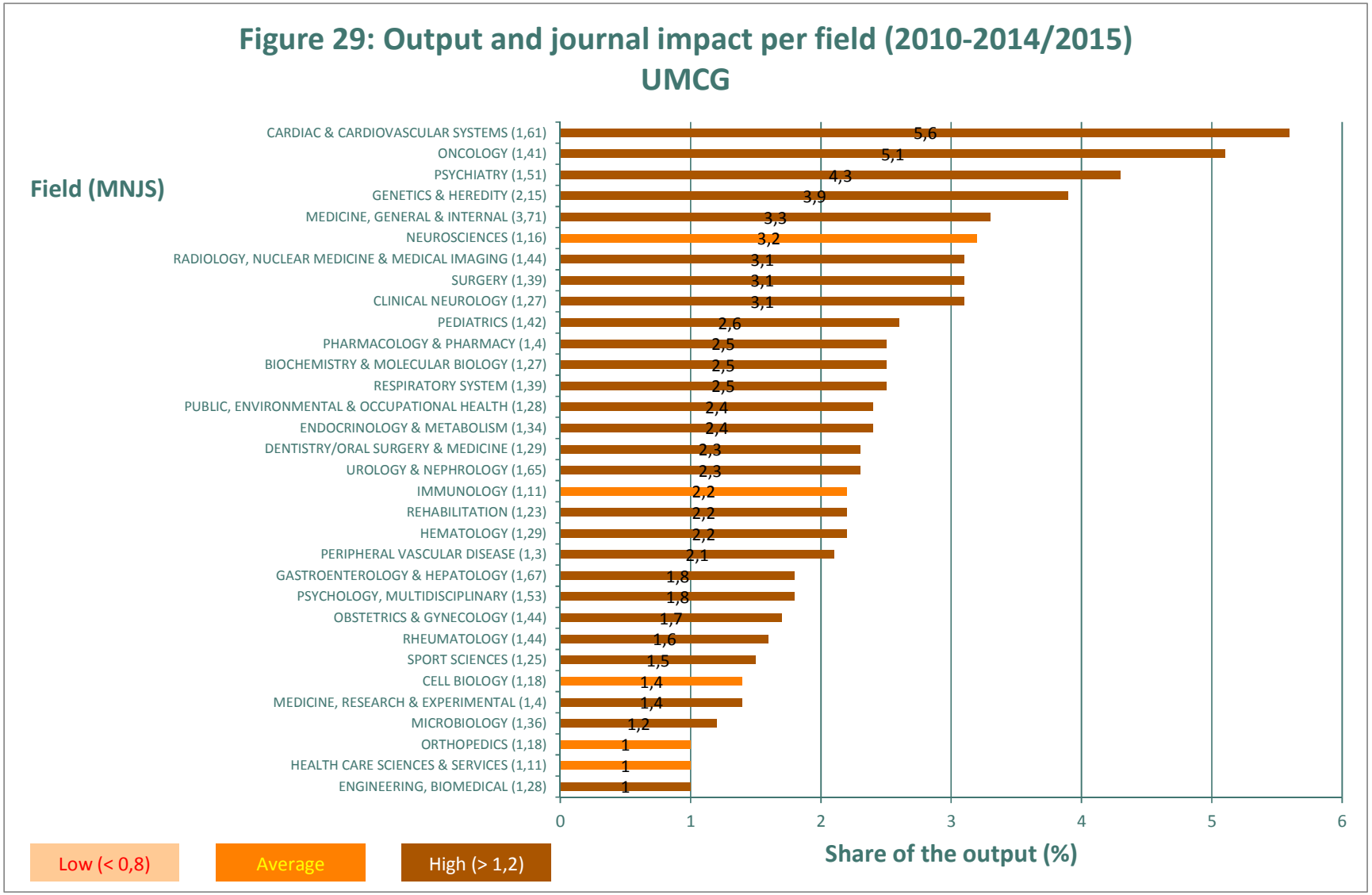


Figure 30: Output and journal impact per field (2010-2014/2015)
UU UMC

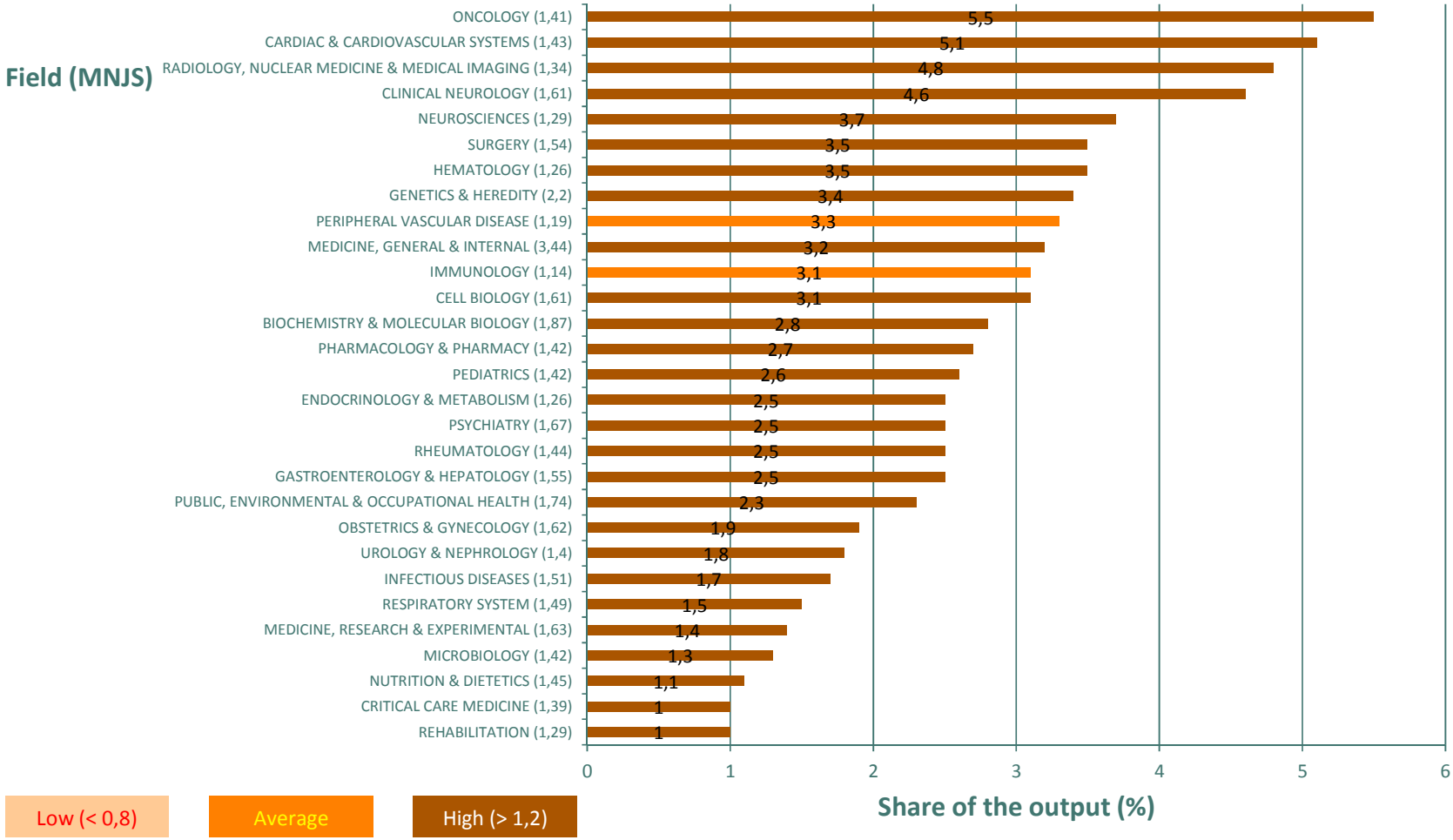


Figure 31: Output and journal impact per field (2010-2014/2015)
UvA AMC

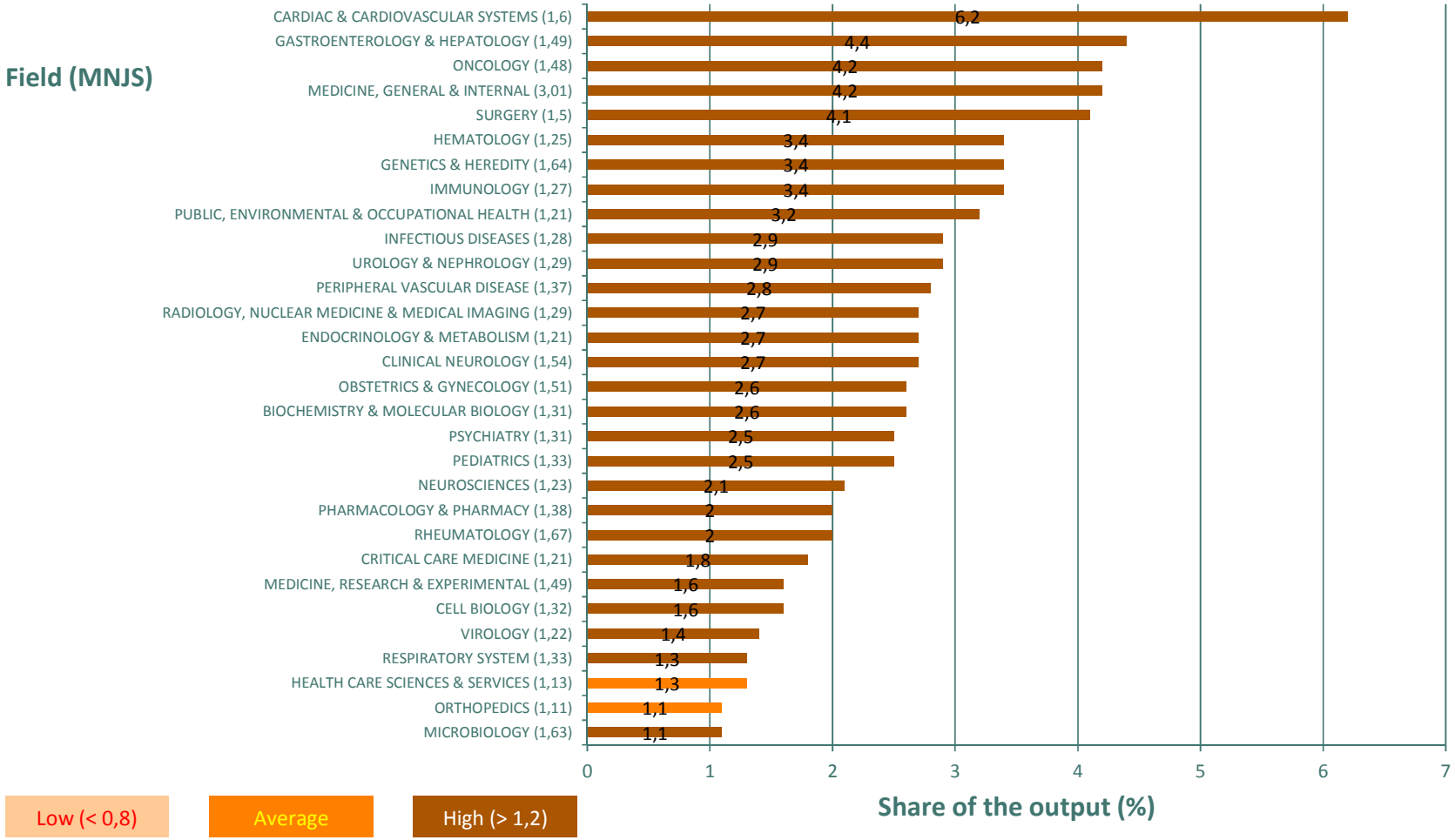
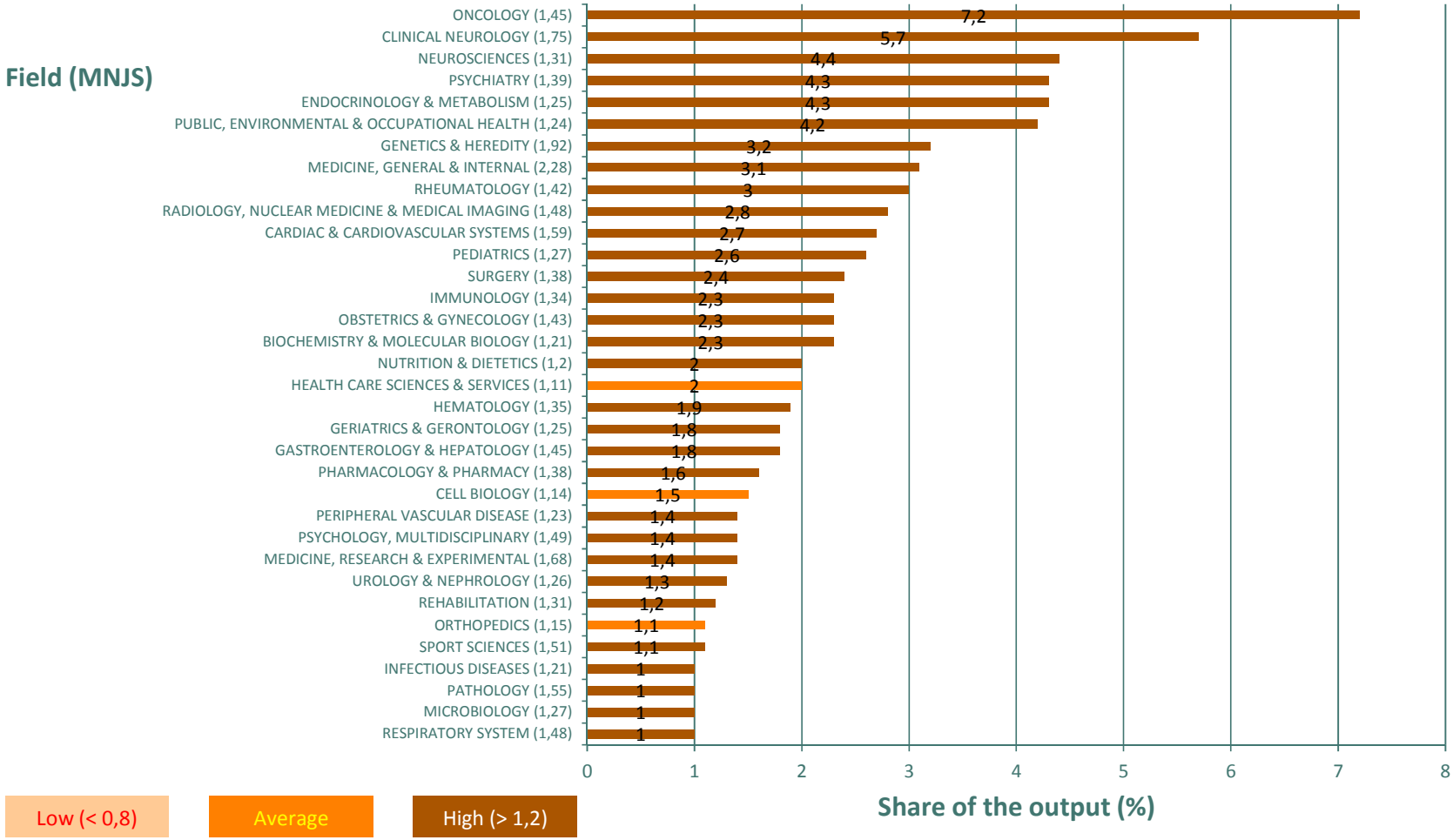


Figure 32: Output and journal impact per field (2010-2014/2015)
VUmc

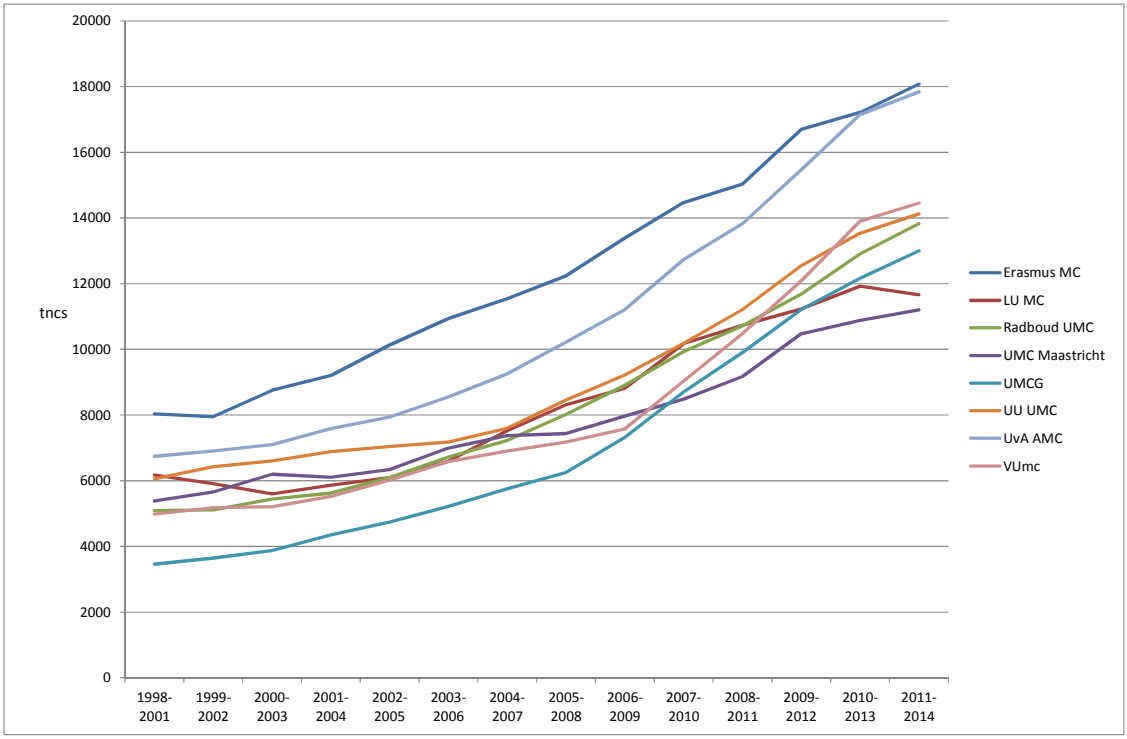


*2.6 The Brute force indicator for Dutch UMCS (P * MNCS values)*

In this section, the focus is on what is called the 'brute force' of a research organization, analog to the ranking of universities (see http://www.LeidenRanking.com the rankings of universities). 'Brute force' is the product of the total number of publications in a period (***P***, multiplied by the field-normalized impact score ***MNCS***. The advantage of this indicator is found in the combination of two indicators that normally describe two different aspects or dimensions of scientific performance.

Figure 34 contains the trend in Brute force scores for the eight Dutch academic medical centers

*Figure 33: Trend in the Brute Force of Dutch UMCS (P*MNCS), 1998-2014/2015*



3. Final remarks

We start this final section with a few general comments on the use of bibliometric indicators for the assessment of research performance. It is our experience in previous studies on research performance in the natural and life sciences, medicine, the humanities, and in the social and behavioral sciences, that bibliometric indicators provide useful information to a peer review committee evaluating research performance. These studies revealed a fair correspondence between the results of bibliometric analyses on the one hand, and judgments on scientific quality by peers on the other hand. In our view, a quality judgment on a research unit, department or institute can only be given by peers, based on a detailed insight into content and nature of the research conducted by the group or institute in question. The citation-based indicators applied in this study, measure the impact at the short or middle-long term of research activities at the international research front, as reflected in publication and citation patterns. ***Impact and scientific quality are not necessarily identical concepts***.

Bibliometric indicators cannot be interpreted properly without background knowledge on both the research units that are evaluated, and the subfields in which the research units are active. In fact, in previous studies we have encountered a few cases in which a bibliometric indicator pointed in one direction (e.g., a low impact), while statements by peers or even other indicators pointed in another direction (e.g., a high quality). Analyzing such discrepancies from a bibliometric point of view, specific limitations related to the bibliometric methodology applied in the study in question may be identified. While in most cases such limitations do hardly affect the results or have no effect at all, in exceptional cases the bibliometric outcomes may provide an incomplete or even distorted picture. For instance, the classification of journals into subfields ('journal categories') may be less appropriate for some research units, particularly when they are active in topics of a multidisciplinary nature. Then, in the calculation of the impact compared to the world subfield citation average, this world average may not be representative for the subfield in which such a research group or institute is active. If there are strong indications that the definition of the (sub)field in terms of WOS journal categories is inadequate, then the journal-based world average (***JCSm***) is more appropriate. In particular, this latter case pertains to developing new interdisciplinary fields.

A second limitation concerns the coverage of the Citation Indices (CI). In specific subfields, particularly in applied or technical sciences, the WOS coverage may be less

adequate. Consequently, for research units who are active in such technical/applied subfields, the bibliometric results may provide an incomplete picture. A second point concerns non-WOS publications (e.g., articles in journals that are not or no longer covered by CI). For a number of research units, valuable additional information may be obtained by retrieving impact data for non-WOS publications.

Another example of a limitation of bibliometric analysis relates to time delays. It may take several years for a collection of papers to generate a high impact. We have analyzed research units that had generated only a moderate impact at the time. Confronted with the bibliometric results, several peers stated that these research units had recently made important contributions to the field. When we updated the results after a few years, several research units indeed showed a sharply rising impact curve.

We do not wish to imply that all discrepancies between bibliometric indicators and peer judgments are necessarily due to problems or limitations of the bibliometric methods applied. Equally, it would not be appropriate to attribute such discrepancies only to peers expressing incorrect or biased views on the scientific quality of a research unit. Still reasoning from the point of view of the bibliometrician, discrepancies between bibliometric indicators and peer judgments often constitute a research problem in itself and often, a considerable effort is required to examine a discrepancy in sufficient detail.

Nevertheless, also peer review has its disadvantages (van Raan 1996). ***Therefore, the appropriate combination of peer-based qualitative assessment and quantitative, particularly bibliometric indicators appears to be the most successful approach in order to reinforce objectivity, transparency, comparability and reproducibility in the assessment of research performance.***

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Appendix A: Explanation of the bibliometric indicators of CWTS

Universiteit Leiden

1. Data collection

1.1 Introduction

Bibliometrics is the quantitative study of written products of research. It is assumed that scientific subjects develop at an international research front (Price, 1963). Research results are communicated in publications that are submitted to evaluation by professional colleagues. In the references of their papers, scientists acknowledge relevant publications by others, as they build on previous work. Therefore, the number of times a publication is referred to gives a partial indication of the 'impact' of a publication, its reception and use by scientists at the research front.

In nearly all scientific fields, the scientific journal is by far the most important medium of communication. The Web of Science database (from here on WoS), which consists of the citation indexes known under acronyms such as SCI, SSCI and A&HCI claims to cover the most important 'leading' international journals and serials (such as Annual Reviews) with a well-functioning referee system. In addition, the overall citation rate of journals is considered, as well as their timeliness of publication, and adherence to international editorial conventions. Regularly, a limited number of new journals are added, while other journals are no longer covered. More 'peripheral' journals, often national in scope, are usually not covered by the CI. The WoS counts about 11,000 journals during the last decade.

Both statistical requirements and imperfections in the citation process (for a discussion see Nederhof, 1988) make it desirable to aggregate across individuals, publications, and citations. As scientific (sub)fields differ in publication and citation patterns (as visible in differences in for example length of reference lists, or age of cited literature), it is usually not meaningful to compare directly the raw impact of publications from one (sub)field with those of a different (sub)field. Therefore, in our studies raw impact scores are compared to the impact of similar publications within the same journal, or within the same (sub)field.

1.2 Specifics on data collection

The present study relates to the publication output of the academic medical centers at Dutch universities. The medical centers supplied publication lists to CWTS, which were matched with the CWTS in-house bibliometric data-system. The bibliometric analysis is covering the period 1998-2014/2015 for all eight academic medical centers. This study

is an update of the study conducted in 2014/2015, for the update CWTS was supplied with the year 2013 as an additional year to the data collected for the previous studies.
Actually, the publication data collected in this study are publication years: papers are included for the year in which they were published in the journal, which does not necessarily coincide with the moment the publications are processed for the WoS. While last year's analysis contained an update for three UMCs output from the past, this year the data collection was limited again to the addition of the output of the year 2014
We considered only papers classified in the WoS as normal articles, letters and reviews, published in source serials processed for the WoS database. Please note that in the indicator set of CWTS (see below), letters are weighted with 0.25 (for an analysis of letters in particular biomedical journals, see van Leeuwen et al, 2007). Other document types, such as meeting abstracts, 'editorials', 'editorial material', corrections, comments, and book reviews were not included (for a discussion on editorials in bibliometric analysis, see van Leeuwen et al, 2013). Also, papers in non-WoS source journals are not counted. A few journals are only partially processed for the WoS. Here, only papers processed for the WoS were included.
A statement needs to be made on a specific type of articles in the WoS database. This concerns the articles published in journals, but forthcoming from a scientific conference. These regular journal articles were in 2008 re-classified as proceedings papers, but after a short while, realizing this was an error, this was changed again in to article/proceeding paper. For this study, this does not influence the results, as we still consider these publications as regular journal articles, and are treated as such. In the future, when the CWTS WoS database also contains proceedings publications, a new situation arises, and adequate steps will be taken to handle these new document types correctly (for a report of this issue see Gonzalez-Albo & Bordons, 2011).

1.3 Explanation of the citation impact measurement

In the standard tables, we apply the method in which citation impact is measured for five year maximum in block of publication years of four year maximum. This works as follows: for the first year in a four year block the impact is measured for five years, for the next year in the block we apply a four year citation window, for the third year in the block we apply a three year citation window, and for the last year in the block we apply a two year citation window. As an example, for the publication years 1998-2001, we apply a citation window that stretches the period 1998-2002, with a five year citation window 1998-2002 for the papers of 1998, a four year citation window of 1999-2002 for the 1999 publications, a three year citation window (2000-2002) for the year 2000, and finally a two year citation window (2001-2002) for the 2001 publications. This moves

through time like roof tiles, in which the next period overlaps the previous. This approach has several advantages, namely in the first place the full usage of all publication years in the analysis in a similar fashion, which creates a consistent approach, and secondly, the aspect that publications contribute to each block in a different way, maturing in time, and overall creating a more smooth development of research impact measurements. With respect to this latter aspect, we have to stress that due to smaller output numbers, on lower levels of aggregation (such as projects or small teams), these outcomes tend to fluctuate more as compared with output numbers related to aggregates on higher levels (universities, UMCS, or divisions within UMCS). This approach is also used for the longer periods analyzed in the study (1998-2014/2015 and 2010-2014/2015). In the case of the former period, we measure the full impact of publications from 1998 up and until 2015, that is, covering 18 years, and covering six years for the 2010 publications. In the case of the latter period, the first year measured is 2010, with a six year citation window, and the last year is 2014, with a two year citation window (2014-2015).

2. Bibliometric indicators

2.1 Output and impact indicators

We calculated the following indicators. The numbering of the indicators corresponds to the position these indicators have in the data tables.

A *first* statistic gives the total number of papers published by the research unit during the entire period ***(P)***. We considered only papers classified as *normal articles*, *letters*, and *reviews*. Meeting abstracts, corrections, and editorials are *not* included. In a few cases, a paper is published in a journal for which no citation data are available, or that is not assigned to a CI journal category. These papers are not considered in the calculation of the indicators presented in the tables below.

The next indicator gives the total number of citations received, without self-citations (***TCS***). In the calculation of all our impact indicators, we disregard author self-citations. We classify a citation as an author self-citation if the citing publication and the cited publication have at least one author name (i.e., last name and initials) in common. In this way, we ensure that our indicators focus on measuring only the contribution and impact of the work of a researcher on the work of other members of the scientific community. Sometimes self-citations can serve as a mechanism for self-promotion rather than as a mechanism for indicating relevant related work. The impact of the work of a researcher on his own work is therefore ignored. As an indication of the self-citation rate we present the percentage of self-citations ***(% Self Cit***), relative to the total number of citations received (***Self Cit***)).

A next indicator is the average number of citations per publication calculated while self-citations are not included (***MCS)***.

Another indicator is the percentage of articles not cited during the time period considered (***PP(uncited)***), excluding self-citations.

International reference values: FCS and JCS

Two international reference values are computed. A first value represents the expected mean citation rate of the subfields (journal categories) in which the research unit is active (***FMCS,*** the **F**ield **M**ean **C**itation **S**core). Our definition of subfields is based on a classification of scientific journals into *categories* developed by Thomson Reuters. Although this classification is certainly not perfect, it is at present the only classification available in the WoS. In calculating ***FMCS,*** we apply the following procedure. The ***FMCS*** takes into account both the type of paper (e.g., normal article, review, and so on), as well as the specific years in which the research unit's papers were published. For example, the number of citations received during the period 2005 - 2012 by

a *letter* published by a research unit in 2005 in field X is compared to the average number of citations received during the same period (2005 - 2012) by all *letters* published in the same field (X) in the same year (2005). Self-citations are excluded from the computation of ***FMCS***.

In most cases, a research unit is active in more than one subfield (i.e., journal category). In those cases, we apply various field impact scores, as related to the individual publications, the selection of the fields being determined by the journals the research unit has used to publish its' research findings. When a journal is classified in multiple subfields, as happens frequently in the WoS, citation scores are computed as follows. Basically, a paper in a journal classified in N subfields is counted as 1/N paper in each subfield, and so are its FMCS scores, so this creates per individual publication an expected mean field citation score.

The second reference value presents the expected mean citation rate of the journals in which the research unit has published (JMCS, the Journal Mean Citation Score). We apply the same exact method for calculating JMCS as we did for FMCS.

Main indicators

The most important indicators compare the number of citations per individual publication within the output of a research unit (***CS***) to the two international reference values, namely the corresponding field and journal expected citation scores of individual publications (***JMCS*** and ***FMCS***, respectively), by calculating the ratio for every single publication against both expected citation scores. Self-citations are excluded in the calculation of the ratios ***CS/FMCS*** and ***CS/JMCS***, to prevent that citation scores are affected by divergent self-citation behavior. Over all ratios of individual publications, we calculate a mean impact score, for both the fields as well as the journals in which the institute has published.

The overall field normalized impact indicator for an institute output is ***MNCS***, the Mean Normalized Citation Score. As this indicator focuses on the broader environment of the group's output, this indicator seems the most suitable indicator of the international position of a research unit. If the ***MNCS*** is above (below) 1.0, this means that the output of the research unit is cited more (less) frequently than an 'average' publication in the subfield(s) in which the research unit is active. The ***FMCS*** values of the individual publications constitute a *world subfield average* in a specific (combination of) subfield(s). In this way, one may obtain an indication of the international position of a research unit, in terms of its impact compared to a 'world' average. This 'world' average is calculated for the total population of articles published in WoS journals assigned to a particular subfield or journal category. As a rule, about 70-80 percent of these papers are authored by scientists from the United States, Canada, Western Europe, Australia and Japan. Therefore, this 'world' average is dominated by the Western world.

A second important indicator, ***MNJS***, is above (below) 1.0 if the citation score of the journal set in which the research unit has published exceeds the citation score of all papers published in the subfield(s) to which the journals belong. In this case, one can conclude that the research unit publishes in journals with a relatively high (low) impact.
The ***MNCS/MNJS*** indicator indicates the impact of papers closely to the publication pattern of research units, that is, the journals in which the units have published. If the ratio ***MNCS/MNJS*** is above 1.0, the impact of a research unit's papers exceeds the impact of all articles published in the set of journals in which the particular research unit has published its papers (the research unit's journal set). A limitation of this indicator is that low impact publications published in low impact journals may get a similar score as high impact publications published in high impact journals. Due to this latter disadvantage, we do not print these scores in the data tables, the indicator is present in the landscaping part of the study however, just as in the part of the study focusing on visibility in top journals in general medicine and multidisciplinary sciences.
It should be noted that the ***MNCS***, ***MNJS*** and the ***MNCS/MNJS*** indicators are not independent. The value of each one of these follows directly from the values of the other two indicators.
For a more detailed discussion on the differences between the former set of CWTS indicators and the current one we refer to the Appendix B.

2.2 Research profiles: analysis of disciplinary orientation

The disciplinary orientation or research profile of a research center is analyzed by classifying its papers according to scientific (sub-)fields. In the WoS, publications are classified by means of the journal in which they appear into (sub-)field categories such as 'Genetics & heredity', 'Oncology', 'Virology, and so on. These WoS journal subject categories are attached to each publication of a research unit. Subsequently, these publications are aggregated for each WoS subfield, and output and impact indicators are computed separately for these aggregates. The purpose of this procedure is to show how frequently a center has published papers in various subfields of science, what and how the impact of the center is in its main subfield(s) of activity.

If a paper appears in a journal that is classified in more than one subject category, the paper (and its citations) is proportionally distributed over the subject categories. Thus, a paper with 7 citations published in a journal categorized in three subject categories is counted as 0.33 publication with 2.33 citations in each subject category.

As an indication, if the ratio ***MNCS*** is lower than 0.8, the impact is said to be 'low' (graphically indicated by a 'lightest colored' bar), if the ratio is higher than 1.2, the impact is designated as 'high' (graphically indicated by a 'dark colored' bar), while a ratio between 0.8 and 1.2 is called 'average' (subsequently indicated by a 'light colored' bar).

Due to ongoing complaints from academics on the way we dealt with the WoS subfield "Multidisciplinary sciences/journals" (which consists of the main multidisciplinary top journals nature, Science, P NAS US and PlosONE, next to many journals of more average impact)), CWTS has decided to solve this is such a way that publications in the journals in this WoS field are added to the WoS subfields these publications could be attributed to on the basis of the cognitive relations these publications have with the literature around them, based upon citation relations. This means that this WoS field as such becomes very small, setting the field under the 1% threshold for display in the research profiles. However, there is attention for the main journals in the field by a separate analysis described under the top research section of the report.

2.3 Analysis of scientific collaboration

The analysis of the various types of scientific cooperation is based upon a typology of papers, which is based on the addresses attached to the publications. In case of the paper carrying only one address, the publications is automatically labeled as a single institute publication. In case of the appearance of at least two different country names on one publication, the publication is automatically considered an international cooperation. The remaining set of publications, carrying two or more addresses within one country, are considered to be the result of national cooperation.

Any classification such as this one has some drawbacks. For example, the typology applied has the disadvantage that in the case of international cooperation publications, if a paper also carries two addresses from one country, the international dimension is the dominant factor in labeling the publication. Furthermore, in case of publications labeled as national cooperation, it can happen that these are actually two addresses of one and the same main institution, which makes it an intra-mural cooperation. However, the typology has been designed in order to have mutually exclusive classes thus simplifying the analysis of collaboration networks. (the strength of such typology is clearly visible through an analysis of international scientific cooperation links, see van Leeuwen, 2009)

2.4 Journal impact profiles: journal to field impact of Dutch academic medical centers

In this analysis we have changed the focus to the choice of the journals in which the researchers in the medical centers published their findings. In a similar way of presenting the research profiles, we now indicate the impact per field not by using the field normalized impact indicator ***MNCS***, but apply the ***MNJS***, to indicate the impact level of the journals (in their respective field(s)) in which the researchers have published their output in the period of analysis.

2.5 Top paper analysis

In addition to the ***MNCS*** indicator, we use another important impact indicator. This is the proportion of publications belonging to the top 10%most highly cited, denoted by PP(top 10%). For each publication of a research group, we determine whether it belongs to the top 10% based on its number of citations of all WoS publications in the same field (i.e., the same WoS subject category) and from the same publication year. The PP(top 10%) indicator of a research entity equals the proportion of its publications belonging to this top 10%. As for ***MCS*** and ***MNCS*** indicators, *letters* are given less weight than *articles* and *reviews* in the calculation of the PP(top 10%) indicator. If a research group has a PP(top 10%) indicator of 10%, it means that the actual number of top 10% publications of the group equals the expected number. A PP(top 10%) indicator of, for instance, 20% means that a group has twice as many top 10% publications as expected. Of course, the choice to focus on top 10% publications is somewhat arbitrary. Next to the PP(top 10%) indicator, we also calculate PP(top 1%), PP(top 2%), PP(top 5%), or PP(top 20%) and PP(top 50%) indicators. In the main tables, we use the PP(top 10%) indicator. The other PP(top *x*%) indicators are presented as a separate analysis in the study.

2.6 Coverage of a bibliometric analysis

Finally, the indicator ***Int Cov*** shows the degree of the total set of references of a unit referring back to the WoS database, thereby indicating the degree of relevance of that WoS covered literature for the communication processes in the field(s) in which the unit is active. A high score means that many references point directly towards the WoS database, and thus that WoS literature is important for the communication process of the unit. This indicates the relevance of the application of bibliometric techniques in the research assessment of the unit. By inclusion of this indicator in the standard tables, we hope to put the scores in the respective data lines in context (as low scores clearly indicate the extra care one should take in interpreting the results presented in the table).

2.7 Basic elements of bibliometric analysis

All above discussed indicators are important in a bibliometric analysis as they relate to different aspects of publication and citation characteristics. Generally, we consider ***MNCS*** as an important indicator for analyzing research performance. This indicator relates the measured impact of a research group or institute to a worldwide, field-specific reference value. Therefore, it is a powerful internationally standardized impact indicator. This indicator enables us to observe immediately whether the performance of a research institute/group or institute is significantly far below (indicator value < 0.5), below (indicator value 0.5 - 0.8), about (0.8 - 1.2), above (1.2 - 2.0), or far above (>2.0) the international (western world dominated) impact standard of the field. The higher the aggregation level, the larger the volume in publications and the more difficult it is to have an average impact significantly above the international level. At the 'meso-level' (e.g., a large institute, or faculty, about 500 – 1,000 publications per year), a ***MNCS*** value above 1.2, could be considered that the institute's impact as a whole is significantly above (western-) world average. Therefore, it is important to split up large institutes into smaller groups (e.g. through the specific analysis of the different UMCs). Only this allows a more precise assessment of research performance. Otherwise, excellent work will be 'hidden' within the bulk of a large institute or faculty. We stress that the other indicators provided in the tables, such as PP(uncited) or %Self Cit do contribute to a further understanding of the research performance analysis of units under study. Together these indicators tend to inform the user of bibliometrics on a variety of aspects in research performance analysis.

Appendix B: Changes in the bibliometric indicators of CWTS

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Introduction

This report provides a short summary of the changes in the bibliometric indicators of CWTS. These changes are the result of internal discussions within CWTS and also of recent insights in the bibliometric literature. The emphasis in this report is on the CPP/FCSm indicator and the MNCS indicator. For a long time, CWTS has been using the CPP/FCSm indicator, but this indicator is going to be replaced by the MNCS indicator. Both indicators will be discussed and the advantages and disadvantages of the MNCS indicator compared with the CPP/FCSm indicator will be summarized. Some other changes in the bibliometric indicators of CWTS will be mentioned briefly.

CWTS is well aware of the importance of continuity in the use of bibliometric indicators. For this reason, the new indicators will sometimes be used together with the old ones in studies of CWTS. When necessary, the new indicators will also be calculated retroactively.

Definitions of the CPP/FCSm indicator and the MNCS indicator

The CPP/FCSm (citations per publication / mean field citation score) indicator is defined as

$$\text{CPP/FCSm} = \frac{(c_1 + c_2 + \ldots + c_n)/n}{(e_1 + e_2 + \ldots + e_n)/n},$$

where n denotes the number of publications, c_i denotes the actual number of citations of publication i, and e_i denotes the expected number of citations of publication i. The expected number of citations of a publication is given by the average number of citations of all publications that appeared in the same field and the same year and that have the same document type (*article*, *letter*, or *review*).

The MNCS (mean normalized citation score) indicator is defined as

$$\text{MNCS} = \frac{1}{n}\left(\frac{c_1}{e_1} + \frac{c_2}{e_2} + \ldots + \frac{c_n}{e_n}\right).$$

As can be seen from the above formulas, the essential difference between the CPP/FCSm indicator and the MNCS indicator is that the former indicator is defined as a ratio of averages while the latter indicator is defined as an average of ratios.

The following example illustrates the calculation of both indicators. Suppose there are three publications, and suppose these publications have the following characteristics:

Publication	Field	Publication year	Actual citations	Expected citations
1	Psychiatry	2005	25	10
2	Surgery	2005	20	20
3	Surgery	2008	15	5

This yields the following indicators:

$$\text{CPP/FCSm} = \frac{(25 + 20 + 15)/3}{(10 + 20 + 5)/3} = 1.71,$$

$$\text{MNCS} = \frac{1}{3}\left(\frac{25}{10} + \frac{20}{20} + \frac{15}{5}\right) = 2.17.$$

Advantages and disadvantages of the MNCS indicator

The MNCS indicator has two important advantages compared with the CPP/FCSm indicator:

- All publications have equal weight in the MNCS indicator, while in the CPP/FCSm indicator older publications and publications from fields with a lot of citation traffic have more weight.
- The MNCS indicator is consistent, while the CPP/FCSm indicator is not. Consistency means that the way in which researchers, departments, or universities are being ranked satisfies certain logical conditions.

The MNCS indicator has two disadvantages compared with the CPP/FCSm indicator:

- The MNCS indicator can be very sensitive to citations to recent publications.
- Publications of the document type *letter* need to be treated in a special way in the MNCS indicator.

These advantages and disadvantages are discussed in more detail below.

Equal weighing of publications in the MNCS indicator

Older publications and publications from fields with a lot of citation traffic on average have a relatively large number of citations. These publications also have a large expected number of citations. In the numerator of the CPP/FCSm indicator, citations to publications from different fields and different publication years are added together. In the denominator, the same is done with expected citations. This causes older publications and publications from fields with a lot of citation traffic to have a relatively high weight in the CPP/FCSm indicator. In the MNCS indicator, the number of citations of a publication is compared directly with the expected number of citations of the publication, without first aggregating over publications. In this way, all publications have equal weight in the indicator. CWTS regards equal weighing of publications from different fields and different publication years as the most natural way to determine the citation score of a set of publications.

The numerical example given in the previous section illustrates the difference between the CPP/FCSm indicator and the MNCS indicator. In this example, publications 1 and 3 have many more citations than expected. Publication 2 has exactly the expected number of citations. Publication 2 originates from a field in which there is much more citation traffic than in the field of publication 1. Furthermore, publication 2 is much older than publication 3. For these reasons, publication 2 has a larger expected number of citations than publications 1 and 3, and consequently publication 2 has more weight in the CPP/FCSm indicator. Since publication 2 has a lower citation impact than publications 1 and 3 (after correcting for field and publication year), giving more weight to this publication leads to a lower citation score. This explains why the MNCS indicator, which gives equal weight to all publications, yields a higher citation score than the CPP/FCSm indicator.

Consistency of the MNCS indicator

Suppose there are two universities (or departments or researchers), A and B, which have the same number of publications. Suppose the citation score of A exceeds the citation score of B. Suppose next that A and B jointly produce a new publication. Since it is a joint publication and, consequently, A and B make the same improvement, it is natural to expect that with the new publication included the citation score of A still exceeds the one of B. An indicator that guarantees this is called consistent. The CPP/FCSm indicator is not consistent. In certain cases, the way in which this indicator ranks two units relative to each other changes in a counter-intuitive manner. The MNCS indicator is consistent and therefore does not have this problem.

Sensitivity of the MNCS indicator to citations to recent publications

Recent publications have a small expected number of citations. In some cases, a relatively small number of citations to a recent publication can therefore be sufficient to

get a high value for the ratio of the actual and the expected number of citations of the publication. For this reason, the MNCS indicator can be very sensitive to citations to recent publications. In some cases, this sensitivity may cause the MNCS indicator to provide a distorted picture of the citation score of a set of publications.

CWTS has two ways of dealing with this disadvantage of the MNCS indicator. First, CWTS calculates the MNCS indicator only for publications that have had at least one year to earn citations. In this way, the expected number of citations of a publication will never be very small, and the sensitivity of the MNCS indicator to citations to recent publications will therefore be limited. Second, confidence intervals can be added to the MNCS indicator. When the MNCS indicator is heavily influenced by citations to recent publications, this will translate into wide confidence intervals.

Special treatment of publications of the document type letter in the MNCS indicator

The general idea of the MNCS indicator is that all publications should have equal weight. However, in the case of publications of the document type *letter*, this principle is difficult to justify. In general, it does not seem fair to give the same weight to a *letter* as to an *article* or *review*. Moreover, since *letters* often have a small expected number of citations, this would cause the MNCS indicator to be highly sensitive to citations to *letters*. For these reasons, *letters* need to be treated in a special way in the MNCS indicator. CWTS chooses to give *letters* a weight of 0.25 in the MNCS indicator. To illustrate this, let's consider the numerical example given earlier. If publication 3 in this example is of the document type *letter*, the MNCS indicator is calculated as

$$\mathrm{MNCS} = \frac{1}{2.25}\left(\frac{25}{10} + \frac{20}{20} + 0.25 \times \frac{15}{5}\right) = 1.89\,.$$

Practical differences between the CPP/FCSm indicator and the MNCS indicator

CWTS has extensively investigated how the CPP/FCSm indicator and the MNCS indicator differ from each other in practice. At the level of universities or large parts of universities (e.g., large faculties), the differences are typically small. Differences of more than five percent are highly exceptional at this level. At the level of departments or research groups, the differences are somewhat larger. Although also at this level there is a strong correlation between the CPP/FCSm indicator and the MNCS indicator, differences up to twenty percent are not exceptional. The main cause of differences seems to be that the MNCS indicator gives more weight to recent publications than the CPP/FCSm indicator.

Other changes in the bibliometric indicators of CWTS

In addition to the change from the CPP/FCSm indicator to the MNCS indicator, several other changes are going to take place in the bibliometric indicators of CWTS. Important changes are:

- The JCSm/FCSm (mean journal citation score / mean field citation score) indicator, which indicates the average citation score of the journals in which one has published, are replaced by the MNJS (mean normalized journal score) indicator.
- The CPP/JCSm (citations per publication / mean journal citation score) indicator, which indicates the journal-normalized citation score of a set of publications, are replaced by an indicator that is based on similar principles as the MNCS and MNJS indicators.
- Indicators based on counting highly cited publications are going to play a more prominent role.
- The stability of indicators is going to get more attention, for instance through the use of confidence intervals.

More information

More information on the changes in the bibliometric indicators of CWTS is available in the publications listed below. In these publications, the decision to move from the CPP/FCSm indicator to the MNCS indicator is discussed in more detail. References to other relevant literature are provided as well.

Waltman, L., van Eck, N.J., van Leeuwen, T.N., Visser, M.S., & van Raan, A.F.J. (2011). Towards a new crown indicator: Some theoretical considerations. *Journal of Informetrics*, *5*(1), 37–47. Available on http://dx.doi.org/10.1016/j.joi.2010.08.001.

Waltman, L., van Eck, N.J., van Leeuwen, T.N., Visser, M.S., & van Raan, A.F.J. (2011). Towards a new crown indicator: An empirical analysis. *Scientometrics* 87 (3), 467-481 . Available on http://arxiv.org/abs/1004.1632.